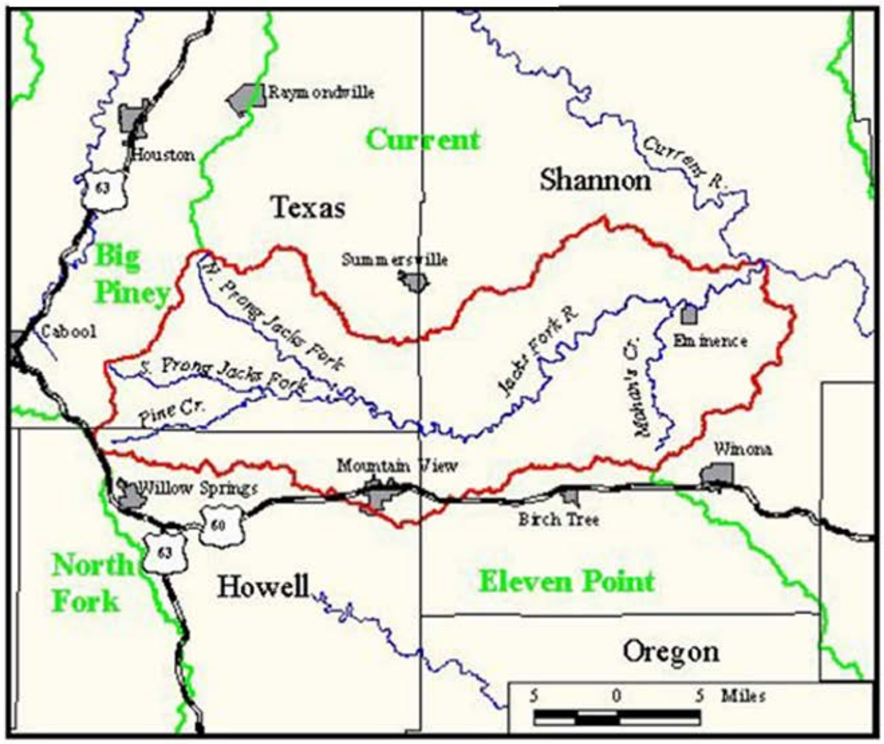

Jacks Fork

Watershed and Inventory Assessment
Prepared by Thomas F. Wilkerson Jr., Fisheries Biologist
Missouri Department of Conservation, West Plains, Missouri

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Acknowledgements

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Executive Summary

The Jacks Fork Watershed occupies a land area of 445 square miles in portions of Howell, Shannon, and Texas Counties. The Jacks Fork River drains directly into the Current River which drains land to the North and East of the Jacks Fork Watershed. The Jacks Fork Watershed is bounded to the South by the Eleven Point Watershed and to the West and Northwest by the North Fork and Big Piney Watersheds.

The Jacks Fork River is formed by the confluence of two streams: the North Prong and South Prong of the Jacks Fork. The North Prong has its beginnings approximately 9 miles south of Raymondville, Missouri, while the headwaters of the South Prong are located approximately 5 miles east of Cabool, Missouri. Both streams join to form the Jacks Fork River northwest of Mountain View, Missouri. From this point, the Jacks Fork flows in an easterly direction for 49.1 miles before joining the Current River northeast of Eminence, Missouri.

The Jacks Fork Watershed occurs within the Ozarks Soil Region and includes five soil associations. The geology of the Jacks Fork Watershed consists primarily of dolomites and sandstone/dolomites of Ordovician age. A significant exposure of Cambrian Dolomite is present in the lower portion of the watershed. In addition, small areas of Mississippian limestone and Precambrian igneous rock are exposed in the lower portion of the watershed. Caves, springs, losing streams, and sinkholes are common in the watershed due to the karst nature of its topography. Analysis of USGS 7.5 minute topographical maps indicate that there are 22 springs within the watershed. However preliminary results of surveys performed within National Park Service boundaries indicate that many more springs exist within the watershed. Alley spring is the largest spring within the watershed with an average discharge of 125 cubic feet per second. Horton orders for streams within the Jacks Fork Watershed have been obtained from a 1:24,000 scale Geographic Information System hydrography coverage. There are 44 third order and larger streams within the watershed. These streams account for a total of approximately 311 stream miles or 26% of the total stream miles within the watershed. The Jacks Fork River is 49.1 miles long and becomes sixth order at the confluence of the North Prong and the South Prong of the Jacks Fork. Permanent stream mileage data obtained from a 1:24,000 scale GIS hydrography coverage for the Jacks Fork Watershed indicates that approximately 152 stream miles (13%) within the watershed have permanent water.

Channel gradient was determined using data digitized from USGS 7.5 minute topographic maps for all fourth order and larger streams within the Jacks Fork Watershed. Composite gradient graphs were constructed for all fifth order and larger streams within the watershed. The Jacks Fork River has an average gradient of 7.1 feet/mile.

Land use/land cover data indicates estimated combined forest/woodland cover within the Jacks Fork Watershed at 76% while grassland/cropland comprises 23% of the total land cover the watershed has two urban areas with a population of over 500 persons. These are the cities of Eminence, Missouri (573 persons) and Mountain View, Missouri (2,036). The population density of the watershed is approximately 15 persons per square mile. One U.S. Highway and four major state routes intersect the watershed. In addition, one rail line intersects the watershed for a short distance on the watershed’s western edge. Approximately 19% of the watershed is in public ownership, most of which is managed by the Missouri Department of Conservation.

Average annual precipitation within the Jacks Fork Watershed is 43.21 inches. The USGS currently (2000) has two active surface discharge gauge stations within the watershed. Data from these stations indicate average daily flows for the Jacks Fork River at Eminence and Jacks Fork River at Alley Spring are 466 cubic feet per second (cfs) and 304 cfs respectively.

Water quality concerns within the Jacks Fork Watershed include gravel dredging, indiscriminate land clearing, high levels of recreational river use, municipal waste water discharges, and the presence of livestock in riparian zones for extended periods. In addition, the potential contamination of the ground water system by poorly constructed and/or maintained septic systems as well as municipal discharges to losing streams is also of concern. There are two municipal waste water discharges within the watershed one of which discharges to a losing stream. Three additional National Pollution Elimination System discharges are also located within the watershed. Water quality within the Jacks Fork Watershed has been negatively impacted by periodically high fecal coliform levels in the past. Five miles of Jacks Fork River from T29N, R3W, section 9 to T29N, R4W, section 26 are currently included in the 1998 303(d) list of impaired waters. Fecal coliform is the pollutant resulting from organic wastes.

Within the Jacks Fork Watershed there are currently two dams which have records within the Dam and Reservoir Safety Program Database. One is a reinforced earth structure located on a tributary of the South Prong of the Jacks Fork River. The height of this dam is 27 feet. The other dam is a reinforced earth structure with a height of 41 feet located on a tributary of Shawnee Creek. It appears that there have been no significant channel alterations anywhere throughout the Jacks Fork Watershed. Small channelization projects have probably occurred on private and municipal property and also during road and bridge construction. Riparian corridor land cover/land use within the watershed consists of more forest/woodland (78%) than grassland/cropland (20%).

The biotic community of the Jacks Fork Watershed is diverse. Sixty seven species of fish, 19 species of mussels, and 5 species of crayfish have been collected within the watershed. Several species of sport fish occur within the watershed including chain pickerel, shadow bass, smallmouth bass, largemouth bass, and warmouth. In addition, a total of 51 "species of conservation concern" are known to occur within the watershed. These include 32 species of plants (flowering plants, ferns, fern allies, and mosses); 2 species of insects; 1 species of crayfish; 4 species of mussels; 5 species of fish; 2 species of amphibians, 3 species of birds; and 2 species of mammals. One species, the gray bat, has both federal and state endangered species status. In addition, the Bachman’s Sparrow is a state endangered species as well as a former federal candidate for listing.

The management goals, objectives, and strategies for the Jacks Fork Watershed were developed using information collected from the Jacks Fork Watershed Inventory and Assessment (WIA) and direction provided by the Missouri Department of Conservation Strategic Plan, the Fisheries Division Five Year Strategic Plan (1995-2000), and the Ozark Regional Management Guidelines. Objectives and strategies were written for instream and riparian habitat, water quality, aquatic biota, and recreational use. All goals are of equal importance. These goals include: (1) Improve riparian and aquatic habitats in the Jacks Fork Watershed, (2) Improve surface and subsurface water quality and quantity in the Jacks Fork Watershed, (3) Maintain the abundance, diversity, and distribution of aquatic biota at or above current levels while improving the quality of the sport fishery in the Jacks Fork Watershed, (4) Increase public awareness and promote wise use of aquatic resources in the Jacks Fork Watershed. The attainment of these goals will require cooperation with private landowners, other divisions within the Missouri Department of Conservation, as well as other state and federal agencies.

Location

The Jacks Fork Watershed occupies a land area of 445 square miles in portions of Howell, Shannon, and Texas Counties. The Jacks Fork River drains directly into the Current River which drains land to the North and East of the Jacks Fork Watershed. The Jacks Fork Watershed is bounded to the South by the Eleven Point Watershed and to the West and Northwest by the North Fork and Big Piney Watersheds.

The Jacks Fork River is formed by the confluence of two streams: the North Prong and South Prong of the Jacks Fork. The North Prong has its beginnings approximately 9 miles south of Raymondville, Missouri, while the headwaters of the South Prong are located approximately 5 miles east of Cabool, Missouri. Both streams join to form the Jacks Fork River northwest of Mountain View, Missouri. From the confluence of the North and South Prongs, the Jacks Fork flows in an easterly direction for 49.1 miles before joining the Current River northeast of Eminence, Missouri (Figure Bk01).

The Jacks Fork Watershed has two cities with populations exceeding 500 persons within or partially within its boundary. These are the cities of Eminence, Missouri (573 persons) and Mountain View, Missouri (2,036) (MSCDC 1997).

One U.S. Highway and four major state routes intersect the watershed. In addition, one rail line intersects the watershed for a short distance on the watersheds western edge (Figure Bk02).

Figure Bk01.

Jacks Fork Watershed
Location

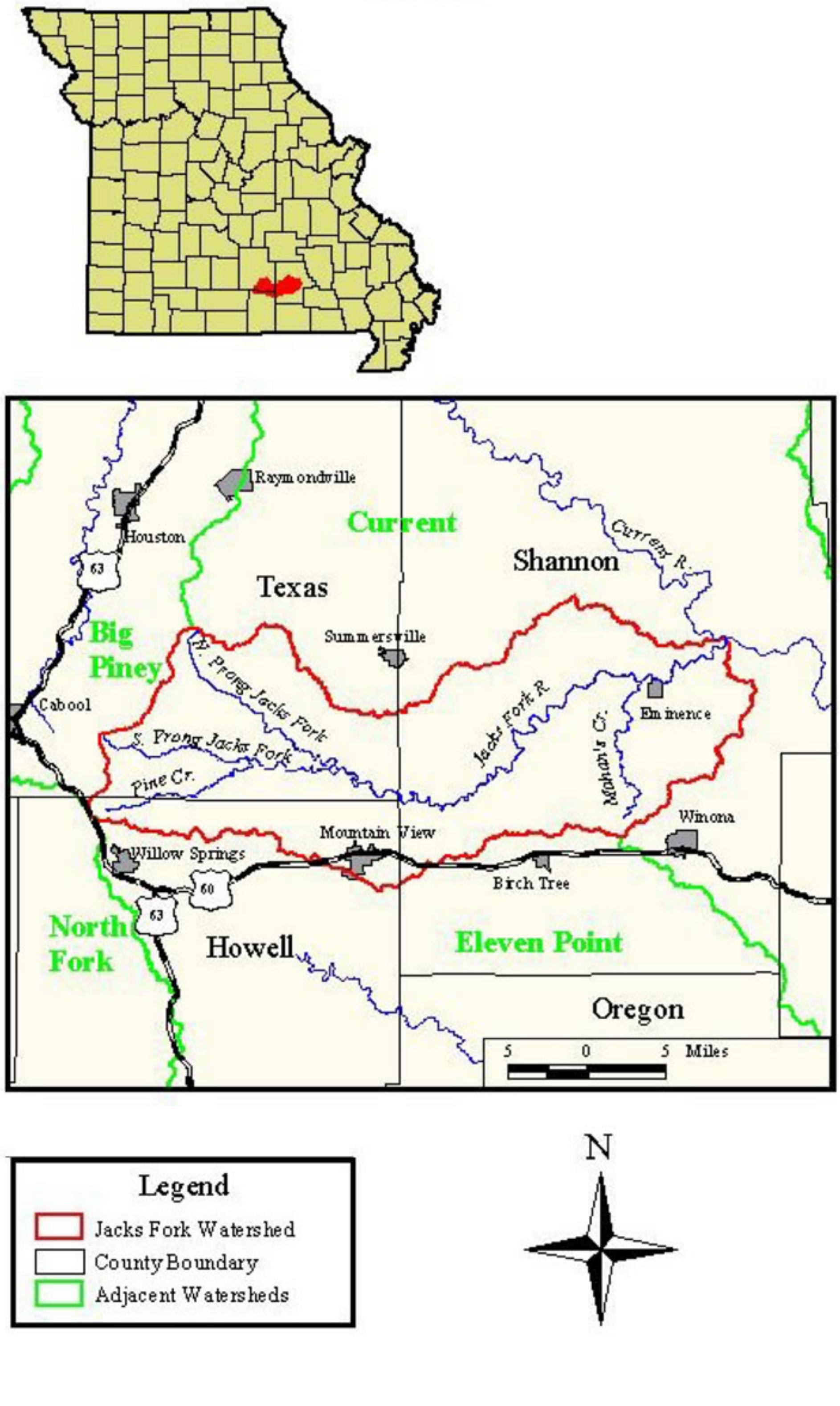
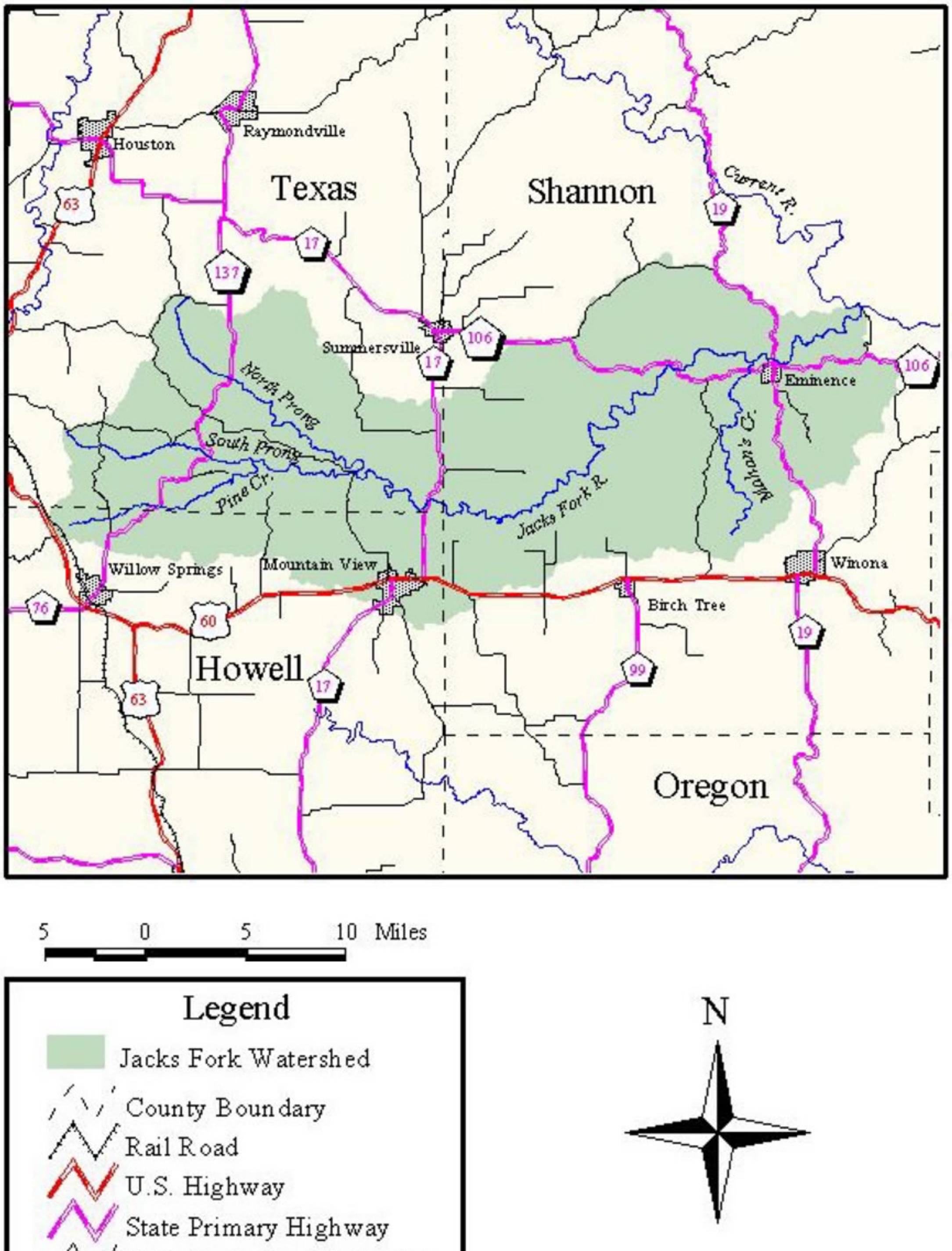


Figure Bk02.

Jacks Fork Watershed
Infrastructure



Geology

Physiographic Region

The Jacks Fork Watershed lies within the Salem Plateau Subdivision of the Ozark Plateau Physiographic Region. The Salem Plateau subdivision is a highly dissected plateau with upland elevations ranging from 1,000 to 1,400 feet above mean sea level (msl) and local relief ranging from 100 - 200 feet in the uplands to 200 - 500 feet elsewhere (MDNR 1986). Elevations within the Jacks Fork Watershed range from a maximum of approximately 1,600 feet msl in the uplands to approximately 580 feet at the confluence of the Jacks Fork and Current Rivers. Local relief data obtained from the Missouri Department of Conservation (MDC) Fisheries Research Fish Collection Database (1998a) indicate a minimum local relief of 316 feet and a maximum of 468 for Missouri Department of Conservation fish collection sites within the watershed.

Soils

The Jacks Fork Watershed occurs within the Ozarks Soil Region. Allgood and Persinger (1979) describe the Ozark Soils Region as "cherty limestone ridges that break sharply to steep side slopes of narrow valleys. Loess occurs in a thin mantle or is absent. Soils formed in the residuum from cherty limestone or dolomite range from deep to shallow and contain a high percentage of chert in most places. Some of the soils formed in a thin mantle of loess are on the ridges and have fragipans, which restrict root penetration. Soil mostly formed under forest vegetation with native, mid-tall and tall grasses common in open or glade area."

The following is a list of soil associations found in the Jacks Fork Watershed:

- **Captina-Clarksville-Doniphan:** "Nearly level to very steep, moderately well drained to excessively drained loamy upland soils that have fragipans or soils that are cherty throughout." (Allgood and Persinger 1979)
- **Captina-Macedonia-Doniphan-Poynor:** "Nearly level to very steep well drained and moderately well drained, loamy upland soils that have fragipans or soils that are cherty throughout." (Allgood and Persinger 1979)
- **Hobson-Coulstone-Clarksville:** "Gently sloping to very steep, moderately well drained to somewhat excessively drained, loamy soils with fragipans or soils that are cherty throughout.
- **Lebanon-Hobson-Clarksville:** "Gently sloping to very steep, moderately well drained to somewhat excessively drained, loamy and clayey soils with fragipans or soils that are cherty throughout." (Allgood and Persinger 1979)
- **Wilderness-Clarksville-Coulstone:** "Gently sloping to very steep, moderately well drained to excessively drained, loamy upland soils that have cherty subsoils or fragipans." (Allgood and Persinger 1979)

Geology

The geology of the Jacks Fork Watershed consists primarily of dolomites and sandstone/dolomites of Ordovician age (Figure Ge01). A significant exposure of Cambrian Dolomite is present in the lower portion of the watershed as well as small exposures of Mississippian limestone and Precambrian igneous rock. The existence of the Precambrian igneous rock within the watershed is the result of the watersheds close proximity to St. Francois uplift. As is the case in most watersheds of the Ozarks, the geology of the Jacks Fork Watershed (primarily consisting of soluble rock formations of dolomites and sandstone dolomites), in combination with an average annual precipitation of over 40 inches has created a karst landscape

within the watershed. This karst landscape is characterized, in part, by a close relationship between the surface water and groundwater systems. Within karst landscapes, points or areas of surface water/ground water interaction include losing streams, sinkholes, and springs.

Losing streams are one manner in which surface water is transported or "lost" to the groundwater system. Within the Jacks Fork Watershed, 8 miles of streams have been designated as "losing" in the Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality (Table Ge01 and Figure Ge02) (MDNR 1999a). Within MDNR 1999a, a losing stream is defined as "A stream which distributes 30% or more of its flow during low flow conditions through natural processes, such as through permeable geologic materials into a bedrock aquifer within two (2) miles' flow distance downstream of an existing or proposed discharge". Due to the specific nature of this definition, many streams within the watershed, which possibly lose large amounts of flow to the groundwater system, may have yet to be surveyed or classified as being "losing" in the broader sense of the word. Further study may be needed in order to develop a comprehensive understanding of the role of losing streams within the watershed.

In addition to losing streams, sinkholes provide another point of surface to groundwater interaction. Based on information presented in Adamski et al. (1995), sinkhole densities within the Jacks Fork Watershed range from approximately 10 per 100 square miles in the middle one-third of the watershed to less than 1 per 100 square miles in most of the western one-third of the watershed with the eastern third having a density of 1 to 10 sinkholes per 100 square miles.

A limited number of dye traces were performed in the watershed by the USFS and the MDNR between 1972 and 1982 (Figure Ge02) (MDNR 1996a). These traces showed the general southeast movement of groundwater within the Jacks Fork Watershed. The longest of these traces was from Jam Up Creek to Big Spring (Current River Watershed), a distance of 37.7 miles. These traces indicated that the watershed not only lost ground water to the main Current River watershed, but also received ground water from the Current River Watershed. Additional dye traces are needed to further determine groundwater movement in the watershed.

Springs are the naturally occurring outlets of groundwater systems. Spring flow accounts, to a large extent, for the higher sustained flows of many Ozark streams relative to streams in other regions of Missouri. Likewise, stream flow within the Jacks Fork Watershed, is also enhanced by springs. Within the Jacks Fork Watershed there are 48 springs (1 per 9.3 square miles of watershed area) as determined from USGS 7.5 minute topographical maps and Vineyard and Feder (1974) (Figure Ge01). This seems to be a relatively low figure in comparison to the North Fork Watershed which has a spring density of 20 springs per square mile. Preliminary results of surveys conducted within National Park Service boundaries in the watershed indicate that significantly more springs exist within the watershed than those displayed on USGS 7.5 minute maps (Gossett, personal communication). Vineyard and Feder (1974) list discharges for 9 springs within the watershed (Table Ge02). Four of these springs have discharges exceeding 1 cubic feet per second (cfs) (Vineyard and Feder 1974). The largest spring within the watershed is Alley Spring which has an average flow of approximately 125 cfs. Discharge data is needed for the remaining springs within the watershed in order to better quantify groundwater influence within the watershed.

Stream Order, Mileage, and Permanency

Stream order is "a hierarchy in which stream segments are arranged" (Judson et al. 1987). The process of stream ordering is accomplished by examining maps and assigning orders to stream

segments based on other streams which flow into them. When two stream segments of the same order join, the new segment they create is the next highest order. For instance, a first order stream would be a stream in which no other streams intersect it. A second order stream is created by the joining of two first order streams. A third order stream is created by the joining of two second order streams and so on. If the main channel of a stream happens to be a lower order than that of the intersecting stream, the main channel assumes the higher order. If the main channel is a higher order stream than the intersecting stream, it maintains the higher order (Figure Ge03). Two types of order are discussed within this document: Horton order which is the maximum order of a stream at its mouth; and Strahler order which is the immediate order of a stream at any given segment of its length. For instance, the Strahler order of No Name Creek at point A in Figure Ge02 is second order while the Horton Order for the main channel designated as No Name Creek is third order.

Horton orders for streams within the Jacks Fork Watershed have been obtained from a 1:24,000 scale Geographic Information System (GIS) hydrography coverage. There are 44 third order and larger streams within the watershed (Table Ge03 and Figures Ge04 and Ge05). These streams account for a total of approximately 311 stream miles or 26% of the total stream miles within the watershed. Of the 44 third order and larger streams within the watershed, 33 are third order (161.5 miles), 7 are fourth order (53.1 miles), and 3 are fifth order (46.8 miles). The Jacks Fork River is 49.1 miles long and becomes sixth order at the confluence of the North Prong and the South Prong of the Jacks Fork.

Stream mileage per order (Strahler) for the Jacks Fork Watershed has been obtained from a 1:24,000 scale GIS hydrography coverage. Of a total of 1,189 miles of stream within the watershed, approximately 749 miles (63%) are first order segments; 219 miles (18)% are second order; 114 miles (10%) are third order; 39 miles (3%) are fourth order; 21 miles (2%) are fifth order; and 49 miles (4%) are sixth order.

Table Ge04 lists length by order for fourth order and larger streams within the Jacks Fork Watershed.

Permanent stream mileage data obtained from a 1:24,000 scale GIS hydrography coverage for the Jacks Fork Watershed indicates that approximately 152 stream miles (13%) within the watershed have permanent water. This equals approximately 1 mile of permanent stream for every 2.9 square miles of drainage area. Lengths of permanent stream by Strahler Order are as follows: first order-6 miles (<1% of all first order miles); second order-11 miles (5)%; third order-33 miles (29%); fourth order-32 miles (82%); fifth order- 21 miles (98%); sixth order-49 miles (100%). Table Ge01 lists estimated permanent stream mileage for third order and larger streams within the watershed.

Drainage Area

The drainage area of the Jacks Fork Watershed is 284,454 acres or 445 square miles. In order to facilitate analysis of watershed characteristics the watershed was divided into 12 units, hence forth referred to as drainage units, based on modified fourteen digit hydrologic units (Figure Ge06). The largest of these drainage units is the North Prong of the Jacks Fork which drains approximately 58.7 square miles (37,568 acres).

Stream Channel Gradient

Stream channel gradient is important for the assessment of problems associated with channel degradation and aggradation, inter and intrawatershed comparisons, selection of fish community

and habitat sampling sites, as well as understanding fish community distribution patterns. Channel gradient has been determined using data digitized from USGS 7.5 minute topographic maps for all fourth order and larger streams within the Jacks Fork Watershed. Composite gradient graphs have been constructed for all fifth order and larger streams within the watershed (Figures Ge07, Ge08, Ge09, and Ge10). Average gradients as well as gradient by Strahler order for all fourth order (Horton) and larger streams are given in Table Ge05. The Jacks Fork River has an average gradient of 7.1 feet/mile. The primary reason for such a relatively low gradient in comparison to other larger Ozark streams is due to the fact that the mainstem of the Jacks Fork splits into the North and South Prongs. Thus, the calculation of average gradient does not include the higher values which would be reflected if the mainstem included headwater stream segments.

Figure Ge01.

Jacks Fork Watershed
Geology & Springs

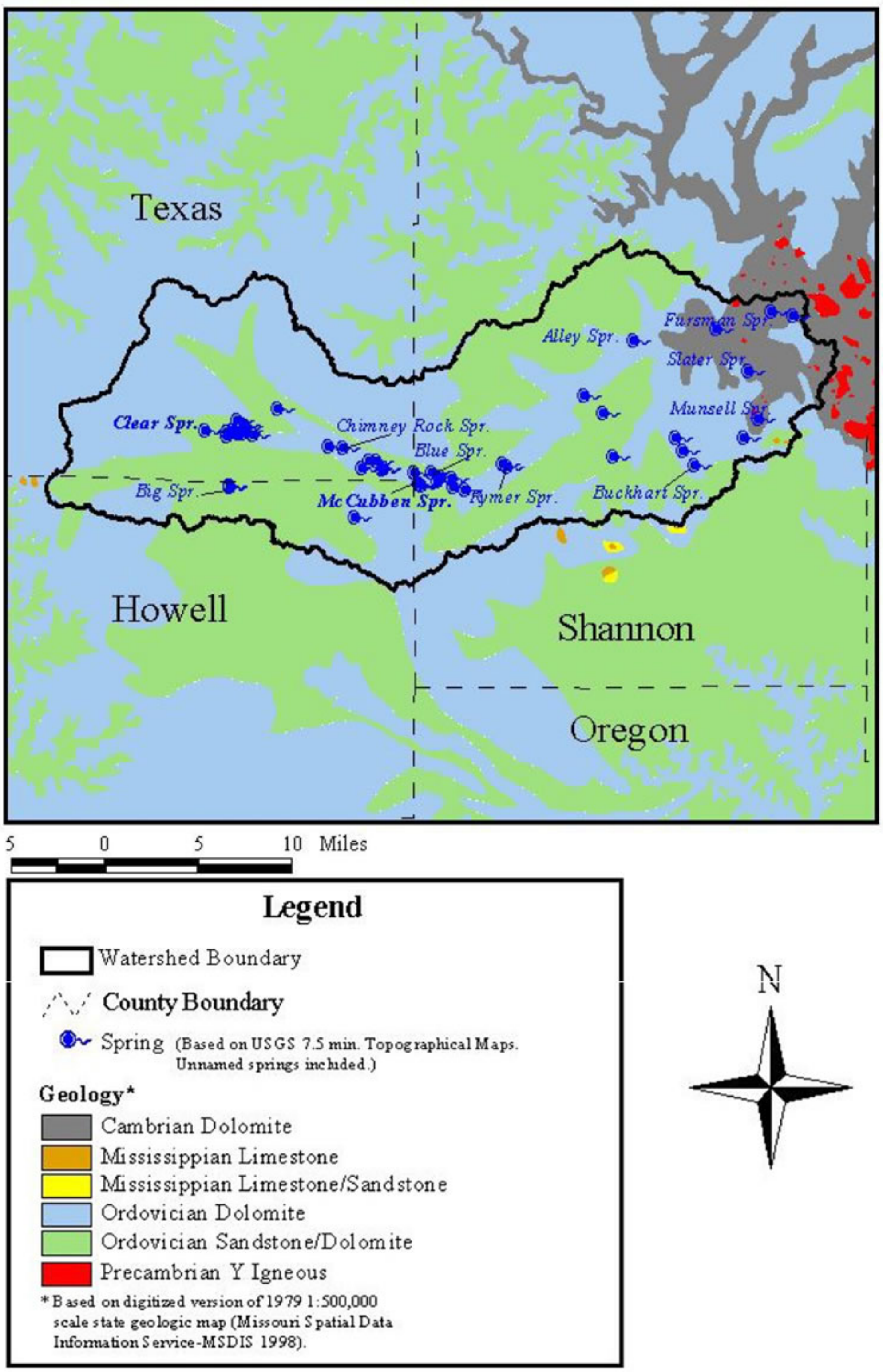


Figure Ge02.

Jacks Fork Watershed
Ground Water Transport

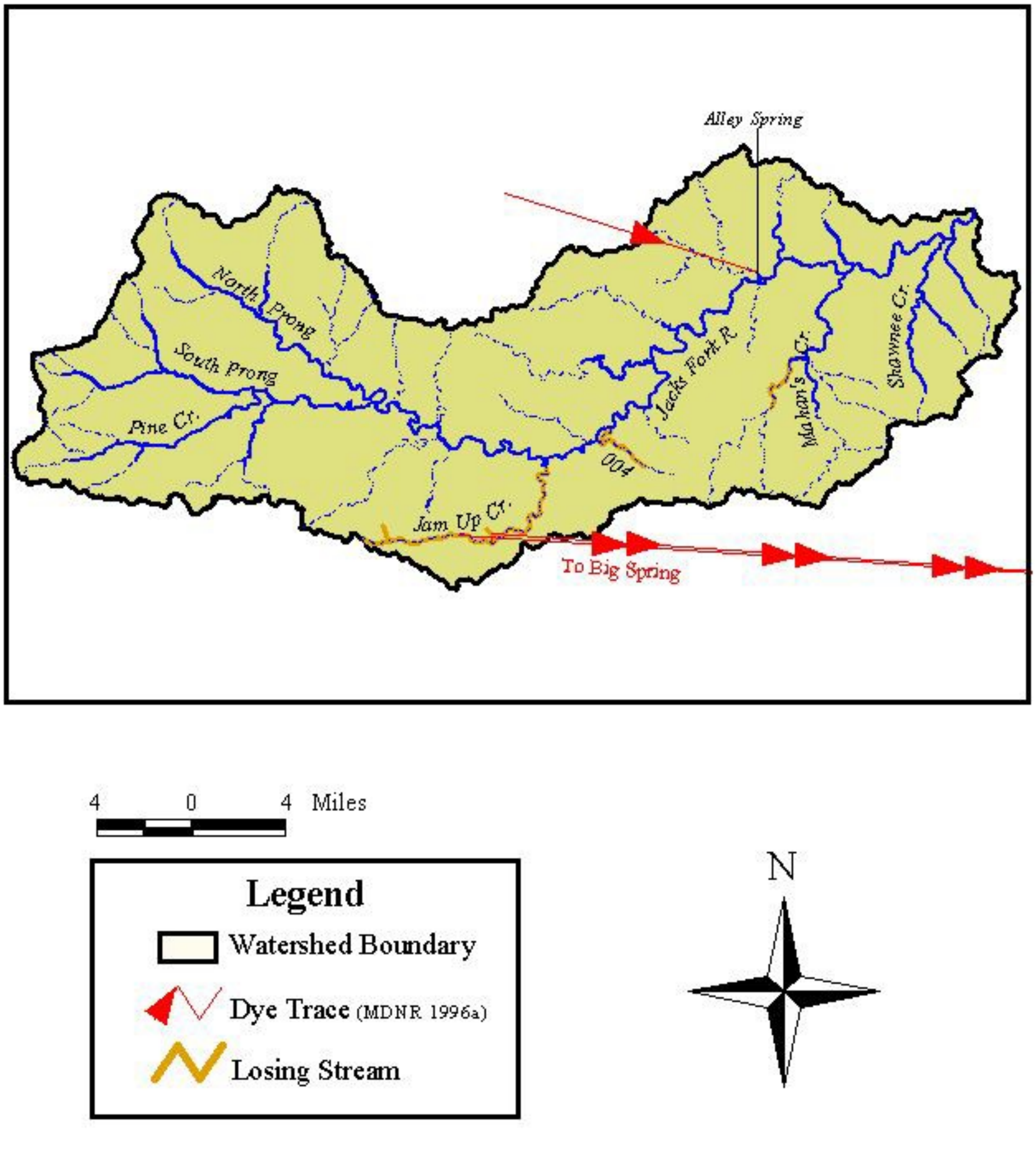
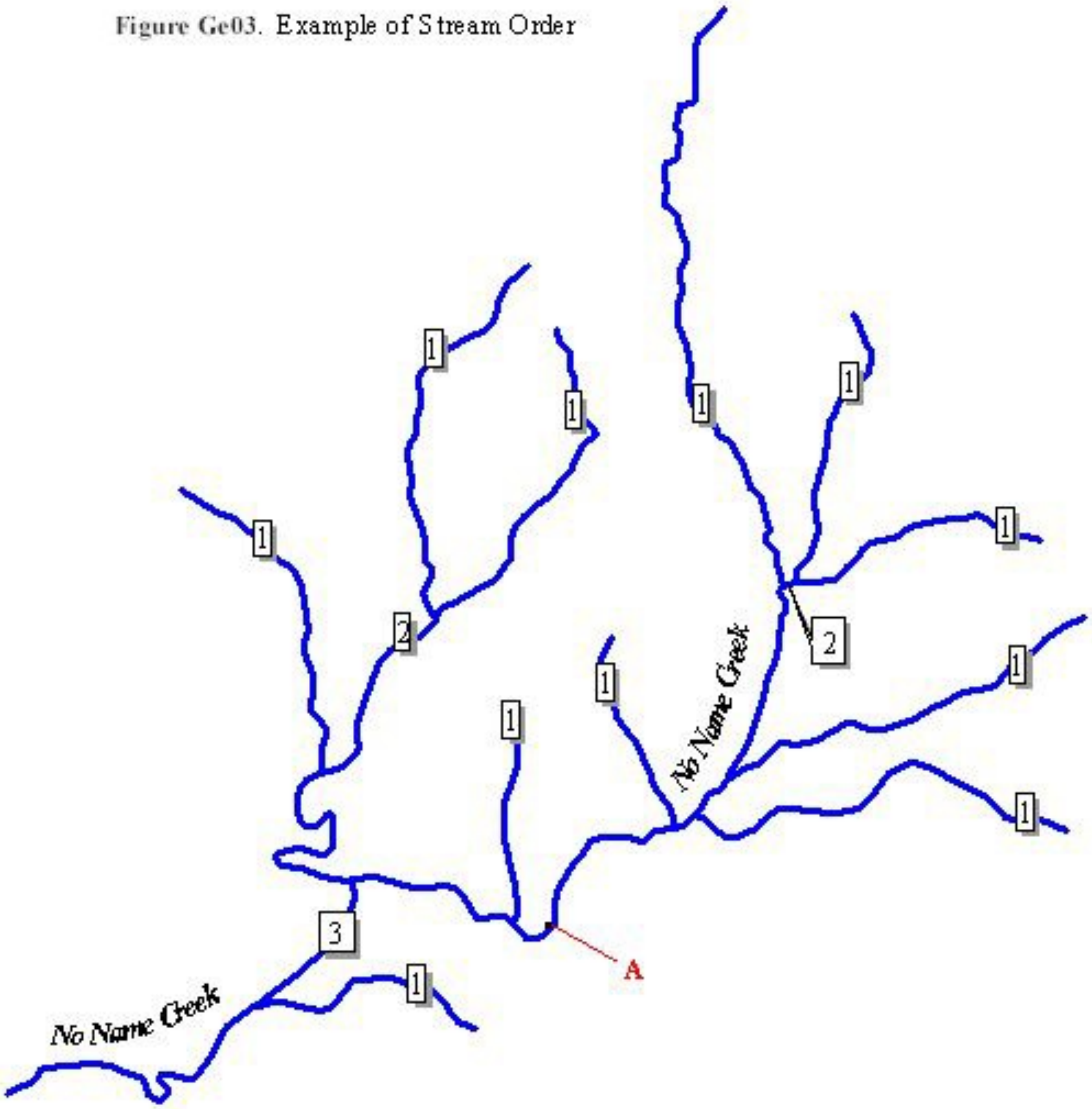


Figure Ge03. Example of Stream Order



The stream segment at Point A has a Horton order of 3 and a Strahler order of 2.

Figure Ge04.

Lower Jacks Fork
Third Order (Horton) and Larger Streams

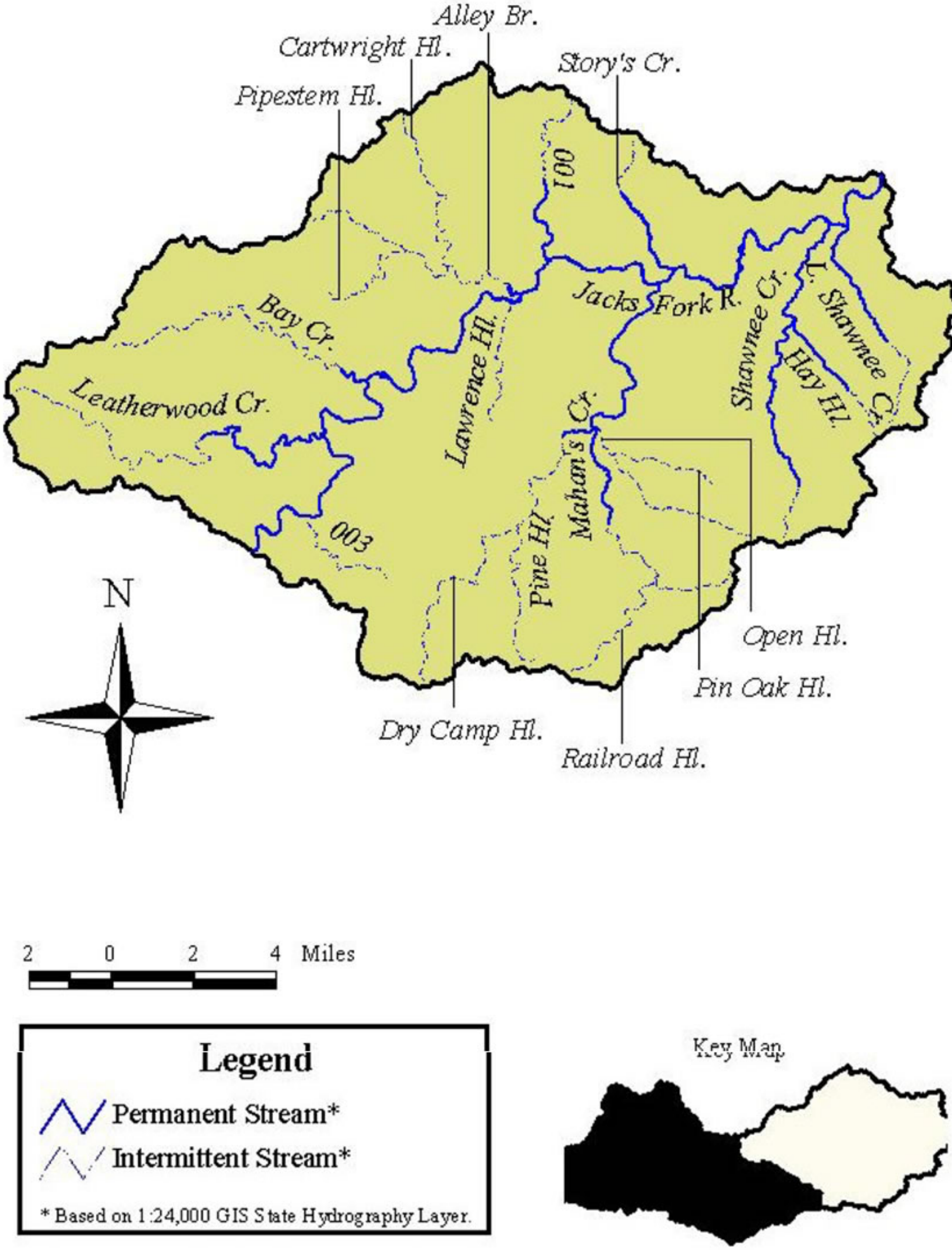


Figure Ge05.

Upper Jacks Fork
Third Order (Horton) and Larger Streams

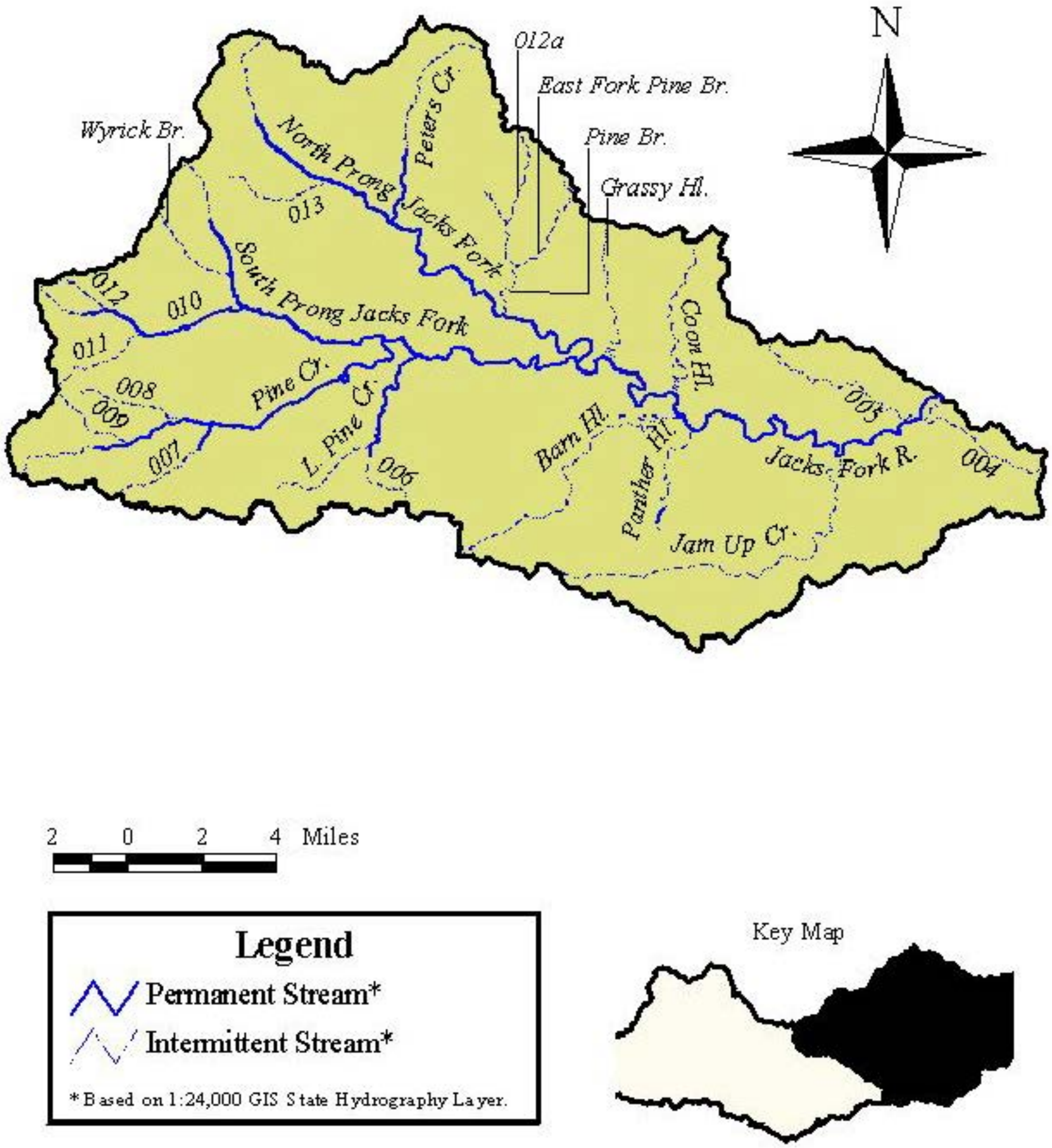
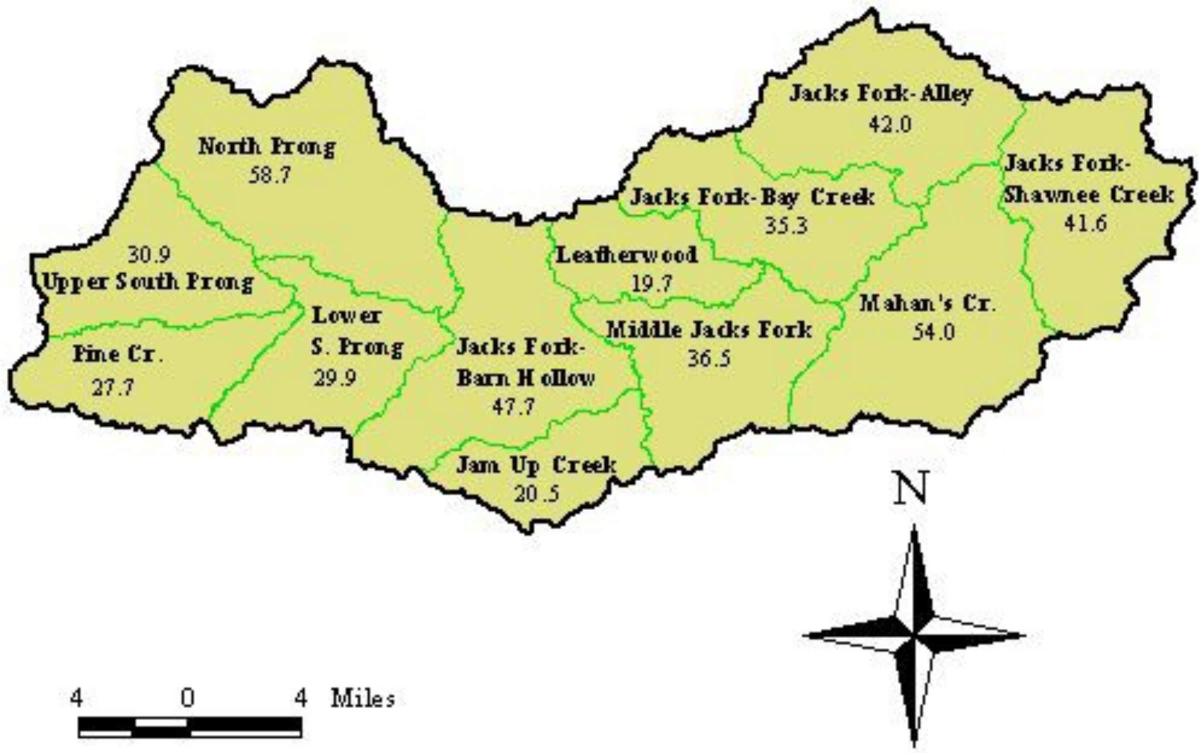


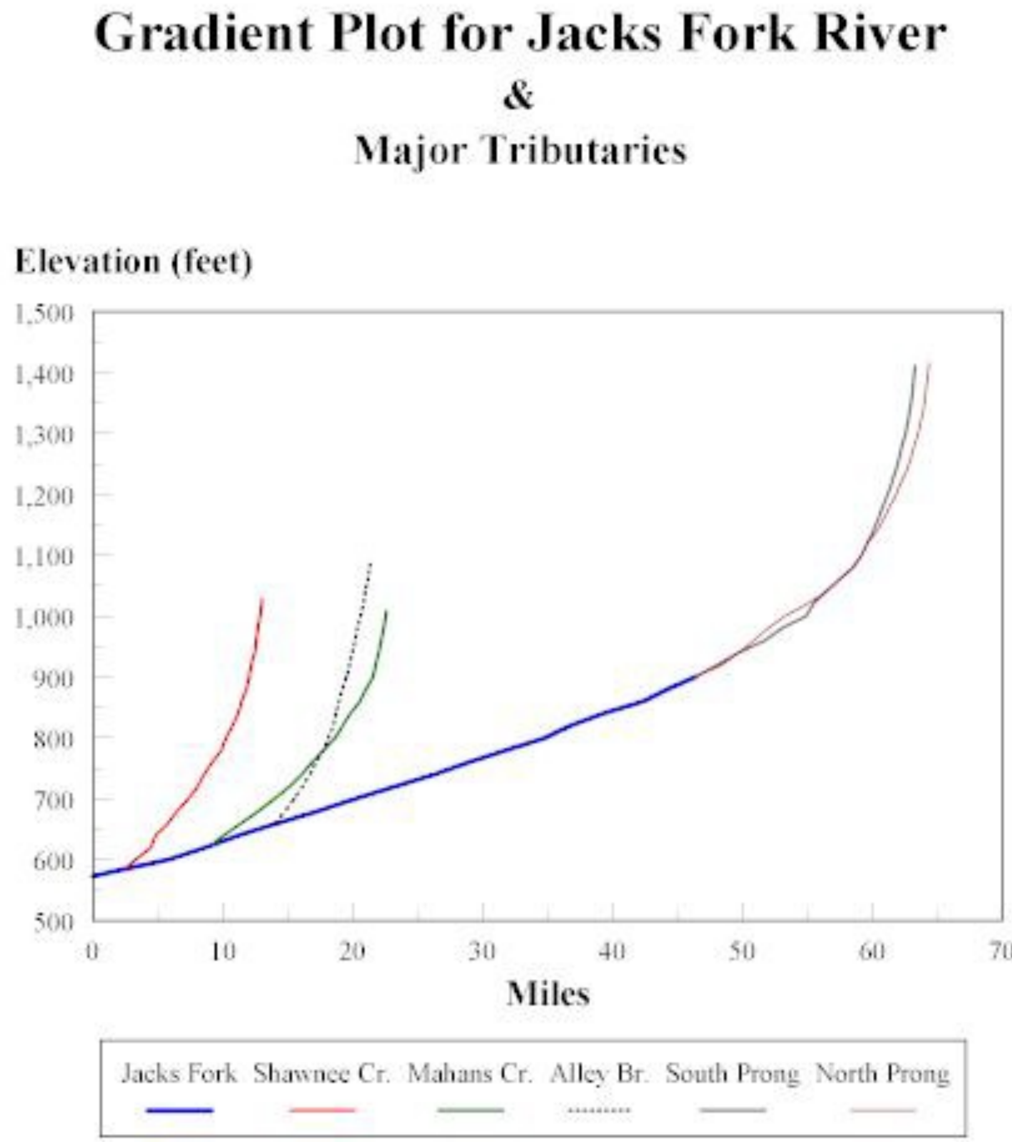
Figure Ge06.

Jacks Fork Watershed
Drainage Units



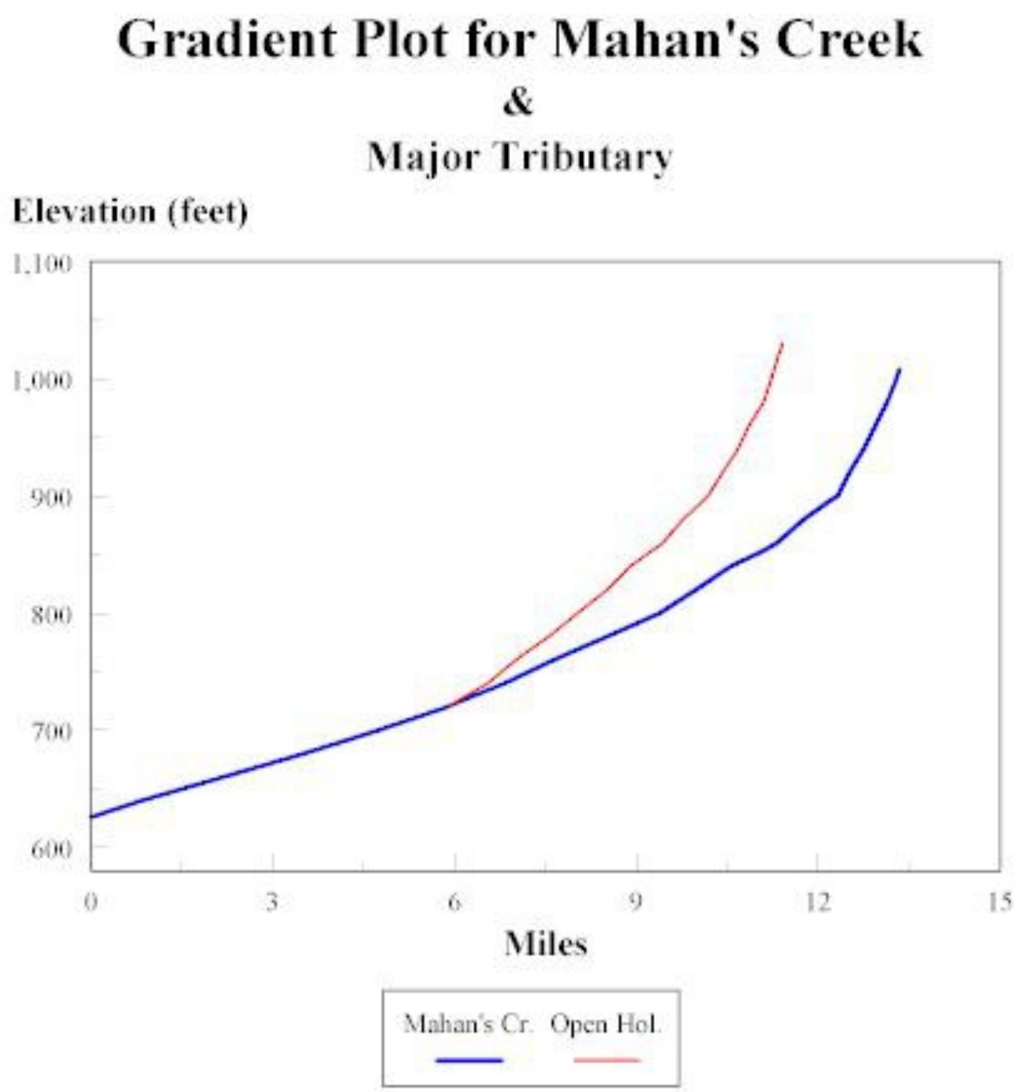
Drainage units based on modified 14 digit hydrologic units.
Watershed areas given in square miles.

Figure Ge07.



Gradient Plot for Jacks Fork River
&
Major Tributaries
Elevation (feet)
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
0
10
20
30
40
50
60
70
Miles
Jacks Fork
Shawnee Cr.
Mahans Cr.
Alley Br.
South Prong
North Prong

Figure Ge08.



Gradient Plot for Mahan's Creek
&
Major Tributary
Elevation (feet)
1,100
1,000
900
800
700
600
0
3
6
9
12
15
Miles
Mahan's Cr.
Open Hol.

Figure Ge09.

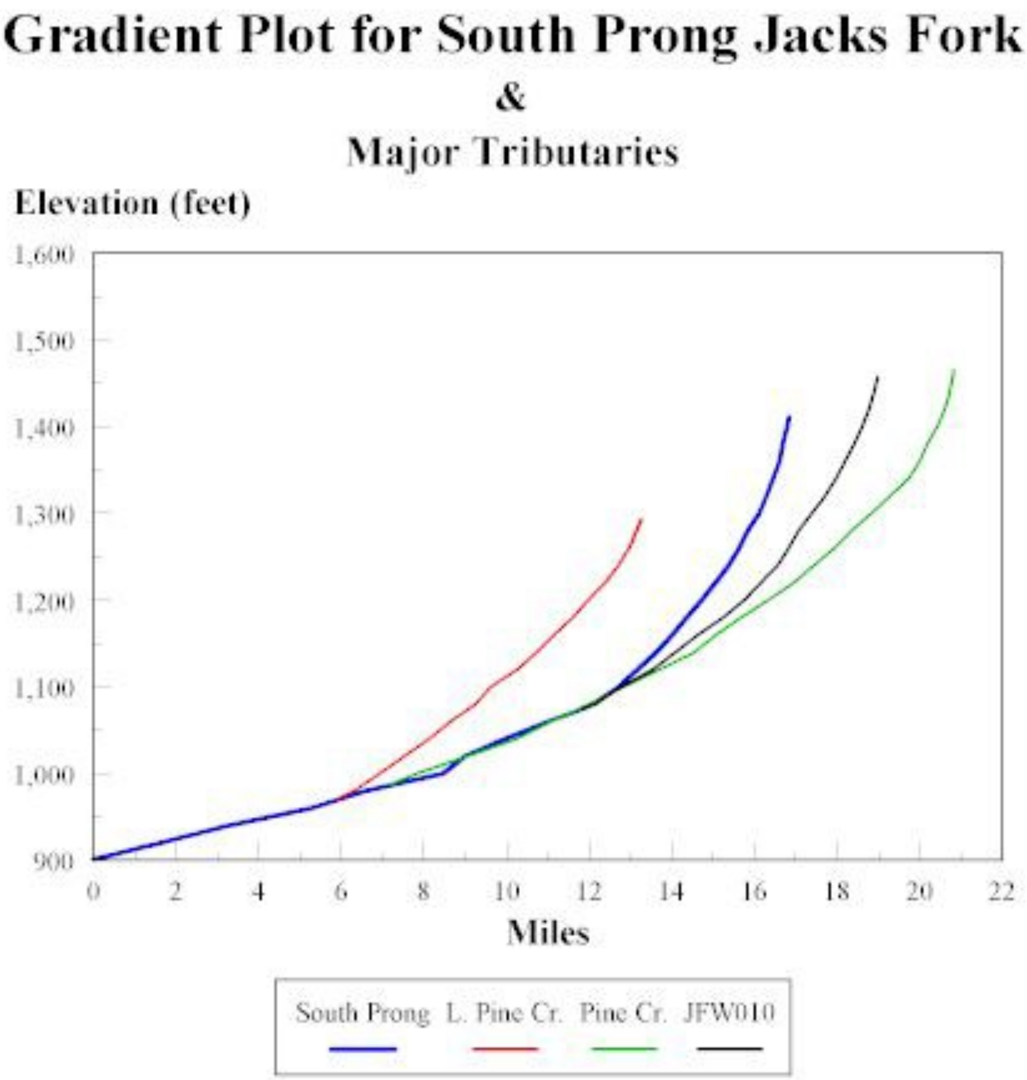
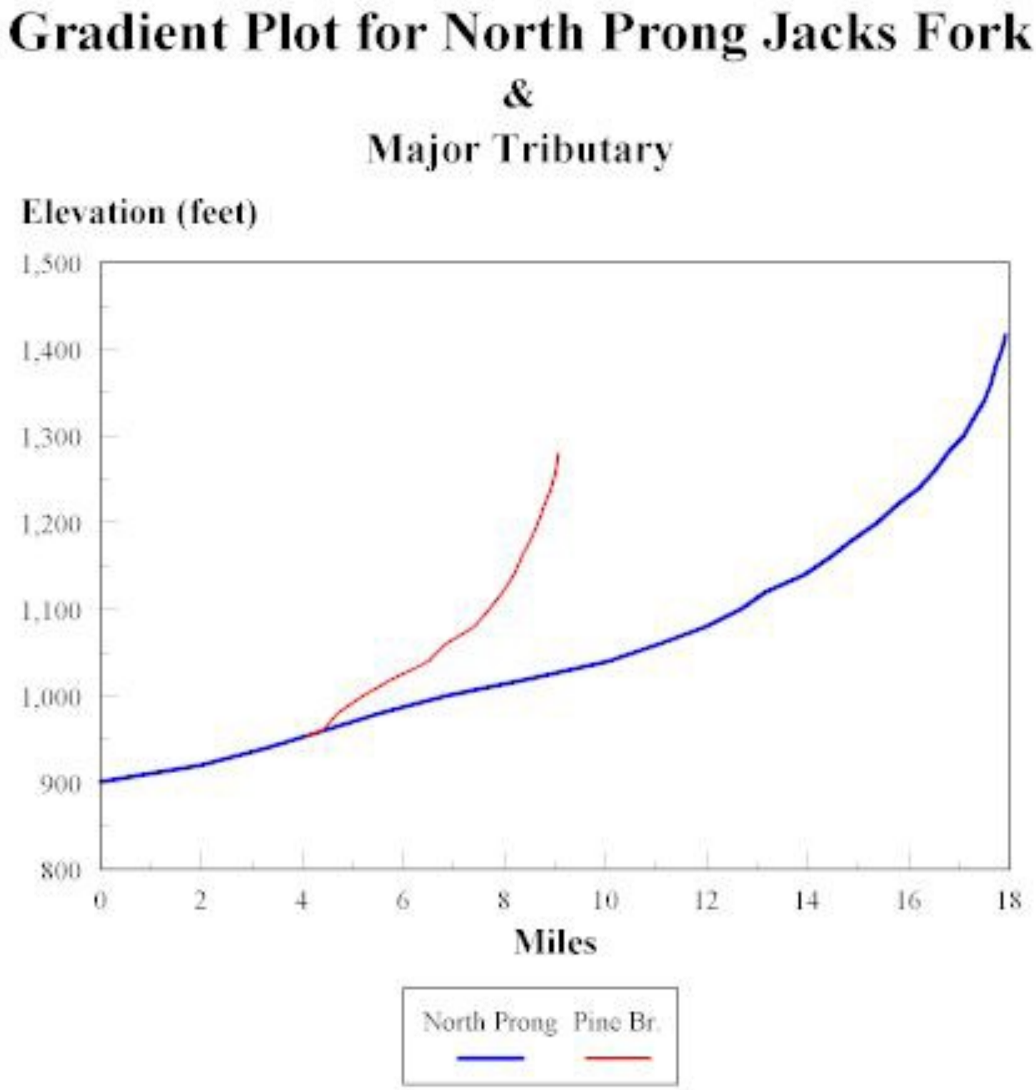

Gradient Plot for South Prong Jacks Fork
&
Major Tributaries
Elevation (feet)
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
0
2
4
6
8
10
12
14
16
18
20
22
Miles
South Prong
L. Pine Cr.
Pine Cr.
JFW010

Figure Ge10.



Gradient Plot for North Prong Jacks Fork
&
Major Tributary
Elevation (feet)
1,500
1,400
1,300
1,200
1,100
1,000
900
800
0
2
4
6
8
10
12
14
16
18
Miles
North Prong
Pine Br.

Table Ge01. Jacks Fork Watershed stream reaches designated as losing in Table J Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7- Water Quality. Code of State Regulations (MDNR 1999a).

Stream	Miles	From	To
Jam Up Creek	5	SW,NE,SE,22,27N,07W	NW,SE,SE,04,27N,06W
Johnny Hollow	1	SW,NE,SE,06,27N,05W	SW,NW,SE,36,28N,06W
Pine Hollow	2	SW,NW,NW,30,28N,04W	NE,NW,NE,17,28N,04W

Note: This table is not a final authority.

Table Ge02. Location and discharge (in cubic feet per second) of selected springs in the Jacks Fork Watershed (Vineyard and Feder 1974).

Name	County	USGS 7.5' Quad. Name	Discharge (cfs)
Alley Spring	Shannon	Alley Spring	125
Big Spring	Howell	Clear Spring	1.41
Blue Spring	Shannon	Pine Crest	7.7
Clear Spring	Texas	Clear Spring	1.41
McCubben Spring	Shannon	Clear Spring	0.88
Rymer Spring	Shannon	Jam Up Cave	0.36
Slater Spring	Shannon	Eminence	0.11
Unnamed	Texas	Pine Crest	0.06
Unnamed	Texas	Pine Crest	0.01

Table Ge03. Third order (Horton) and larger streams of the Jacks Fork Watershed.

Stream Name	Order	USGS 7.5 Quad At Stream Mouth	Name and Order Receiving Stream	Length	
				P	T
Jacks Fork R.	6	Eminence, MO	Current R.-7	49.1	49.1
Little Shawnee Cr.	3	Eminence, MO	Jacks Fork R.-6	3.8	6
Shawnee Cr.	4	Eminence, MO	Jacks Fork R.-6	8.5	9.9
Hay Hol.	3	Eminence, MO	Shawnee Cr.-4	2.6	3.9
Story's Cr.	3	Eminence, MO	Jacks Fork R.-6	2.7	4.1
Mahan's Cr.	5	Alley Spring, MO	Jacks Fork R.-6	8.7	13.2
Pine Hol.	3	Bartlett, MO	Mahan's Cr.-5	0.9	8.1
Dry Camp Hol.	3	Bartlett, MO	Pine Hol.- 3	0	6
Open Hol.	4	Bartlett, MO	Mahan's Cr.-5	0	5.2
Pin Oak Hol.	3	Bartlett, MO	Open Hol.-4	0	2.8
Railroad Hol.	3	Bartlett, MO	Mahan's Cr.-4	0	4
JFW001	3	Alley Spring, MO	Jacks Fork R.-6	2.5	5.5
Alley Branch	4	Alley Spring, MO	Jacks Fork R.-6	0.6	7.1
Pipestem Hol.	3	Alley Spring, MO	Alley Branch-4	0	3.2
Cartwright Hol.	3	Alley Spring, MO	Alley Branch-4	0	5.1
Lawrence Hol.	3	Alley Spring, MO	Jacks Fork R.-6	0	3.5
Bay Cr.	3	Jam Up Cave, MO	Jacks Fork R.-6	1	9.2
Leatherwood Cr.	3	Jam Up Cave, MO	Jacks Fork R.-6	5.6	5.6
South Prong Leatherwood Cr.	3	Jam Up Cave, MO	Leatherwood Cr.-3	0	7.4
JFW003	3	Jam Up Cave, MO	Jacks Fork R.-6	0	4.3
JFW004	3	Jam Up Cave, MO	Jacks Fork R.-6	0	4.8
JFW005	3	Jam Up Cave, MO	Jacks Fork R.-6	0	5.5
Jam Up Cr.	3	Jam Up Cave, MO	Jacks Fork R.-6	0	11.8
Panther Hol.	3	Pine Crest, MO	Jacks Fork R.-6	0	3.6
Barn Hol.	3	Pine Crest, MO	Jacks Fork R.-6	0	10
Coon Hol.	3	Pine Crest, MO	Jacks Fork R.-6	0	6.5
Grassy Hol.	3	Pine Crest, MO	Jacks Fork R.-6	0	4.9
South Prong Jacks Fork	5	Pine Crest, MO	Jacks Fork R.-6	14.4	16.3
Little Pine Cr.	4	Clear Springs, MO	S. Prong Jacks Fork-5	3.6	6.9
JFW006	3	Clear Springs, MO	L. Pine Cr.-4	0.4	2.3
Pine Cr.	4	Clear Springs, MO	S. Prong Jacks Fork-5	10.6	13

Stream Name	Order	USGS 7.5 Quad At Stream Mouth	Name and Order Receiving Stream	Length	
				P	T
JFW007	3	Willow Springs, MO	Pine Cr.-4	0.9	3.5
JFW008	3	Willow Springs, MO	Pine Cr.-4	0	3.3
JFW009	3	Willow Springs, MO	Pine Cr.-4	0	2.5
JFW010	4	Willow Springs, MO	S. Prong Jacks Fork-5	5.2	6.7
JFW011	3	Willow Springs, MO	JFW010-4	0	3
JFW012	3	Willow Springs, MO	JFW010-4	0	1.7
Wyrick/Nigman Branch	3	Willow Springs, MO	S. Prong Jacks Fork-4	0	3
North Prong Jacks Fork	5	Pine Crest, MO	Jacks Fork R.-6	15.4	17.3
Pine Branch	4	Clear Springs, MO	N. Prong Jacks Fork-5	0	4.3
JFW012a	3	Eunice, MO	Pine Branch-3	0	2.8
East Fork Pine Branch	3	Clear Springs, MO	Pine Branch-4	0	3.5
Peters Cr.	3	Eunice, MO	N. Prong Jacks Fork-4	2.3	6.7
JFW013	3	Eunice, MO	N. Prong Jacks Fork-4	0	3.4

P-Permanent Stream Miles (Determined from 1:24,000 scale GIS hydrography coverage)
T-Total Stream Miles (Determined from 1:24,000 scale GIS hydrography coverage)
Abbreviations: Br.-Branch, Cr.-Creek, Hol.-Hollow, R-River

Table Ge04. Stream length for order and total length for fourth order and larger streams in the Jacks Fork Watershed.

Stream Name	Length for Order (Miles0						Total Length
	6	5	4	3	2	1	
Jacks Fork R.	49.6	North Prong/South Prong					49.6
Shawnee Cr.			3.2	5.5	0.7	0.5	9.9
Mahan's Cr.		5.7	5.1	1	0.4	1	13.2
Open Hol.			0.8	2.9	0.2	1.4	5.2
Alley Br.			2.7	1.5	1.1	1.8	7.1
South Prong Jacks Fork		11.6	1	1.8	1	0.9	16.3
Little Pine Cr.			3.6	2.1	0.6	1.2	7.4
Pine Cr.			9.5	2.5	0.6	0.4	13
JFW010			3.2	1.3	1.5	0.6	6.7
North Prong		4	7.7	3.1	1.7	0.9	17.3
Jacks Fork			1.7	1.5	0.4	0.7	4.3

Table Ge05. Stream gradient by Strahler Order and average gradient for fourth order (Horton) and larger streams in the Jacks Fork Watershed.

Stream Name	Gradient by Order (feet per mile)						Average Gradient ft/mi
	6	5	4	3	2	1	
Jacks Fork R.	7.1	North/South Prong					7.1
Shawnee Cr.			22.7	36	80.6	138	42.1
Mahan's Cr.		16.1	25.5	39.3	77.6	110.4	28.6
Open Hol.			33.7	43.3	57.4	95.6	56.2
Alley Br.			28.4	42.1	75.6	101.5	57.5
South Prong Jacks Fork		14.7	30.9	50.9	73.1	130.1	30.3
Little Pine Cr.			34.5	43.7	59.5	96.8	43.7
Pine Cr.			24	44.1	89.8	158.5	35
JFW010			31.1	47	74.7	130.7	53.7
North Prong Jacks Fork		12.2	15.8	35.3	55.9	130.1	28.7
Pine Br.			38.7	39.8	69.3	138.3	65.4

Land Use

Historic Land Cover/Land Use

Historical land cover within the uplands of the Jacks Fork Watershed primarily consisted of oak and mixed pine/oak forest composed of black and white oak species as well as shortleaf pine with an open understory of shrubs and wild grasses such as bluestem (Nigh 1988 and MDC 1997). Occasional prairie and savanna openings were also common in some areas. Land cover of the sideslopes consisted of oak and oak/pine forests composed of black and white oak species as well as walnut and hickory with occasional glade and woodland type openings associated with exposed slopes and ridges having shallow soils. Valley bottom land cover consisted of mixed hardwood or oak/pine forest with occasional fen openings.

The Ozarks are believed to have first been explored approximately 14,000 years ago by semi nomadic Native American tribes which subsisted as hunters and foragers (Rafferty 1980, Jacobson and Primm 1994). Approximately 1000 B.C., tribes on the fringes of the Ozarks became less nomadic, existing in more permanent villages and incorporating agricultural practices as a means of subsistence. Tribes in the Ozarks interior did not begin adopting these practices until 900 A.D. By 1500 A.D. this culture had disappeared as large agricultural based villages began to grow along the eastern fringe of the Ozarks and along the Mississippi River. During this period the interior of the Ozarks was used primarily as a seasonal hunting ground as well as a source for flint and chalcedony (a type of quartz) for making tools. It is believed that a climatic shift to cooler, drier summers and the resulting failure of maize crops, on which early agriculture was based, may have caused an abrupt abandonment of the larger villages. Remnants of these villages and tribes reassembled to form the Osage Tribe which existed throughout much of the Ozarks and was present as European settlement of the area began to occur in the late 1700s and early 1800s (Jacobson and Primm 1994). Native American use of fire, as well as naturally occurring incidences of fire (i.e. lightning strikes), are believed to have been a large factor in determining the types of vegetation found by Schoolcraft and others as exploration of the Ozarks interior began to occur after the Louisiana Purchase of 1803. Native Americans are believed to have set fires for many reasons including harassment of enemies as well as an aid in hunting. These fires stimulated warm-season grasses such as bluestem and eliminated woody undergrowth thus creating open woodlands or savannas.

European settlement of the Ozark fringe began in the early 1700,s under French and, later, Spanish political control. After the Louisiana Purchase of 1803, American settlers began settling the same areas earlier occupied by the Spanish and French. The Osage, in treaty with the federal government, relinquished claims to much of the Ozarks interior in 1808 although they refused to relinquish their hunting rights in this area (Rafferty 1980). Settlement of the Ozarks Interior increased after the war of 1812 (Jacobson and Primm 1994). Many of the early settlers came from states such as Indiana, Illinois, Kentucky, Virginia, and Tennessee (Rafferty 1983). Most of these states were previously considered the frontier prior to the Louisiana Purchase, thus many of these settlers brought along skills they had learned for survival in frontier territory. Early settlers subsisted by hunting and fishing as well as maintaining gardens in the small bottomland areas which they cleared. In addition, early settlers raised livestock which grazed on the open range of the slopes and uplands in the summer. In the winter, livestock were fed from forage crops cultivated and harvested from the bottom lands (Jacobson and Primm 1994). The annual practice of burning was continued by early settlers in order to enhance the livestock forage of the uplands. In addition to the influx of settlers of European origin which occurred after the war of

1812, Native American tribes such as the Cherokee, Shawnee, and Delaware which had been displaced from the East began moving through the region (Jacobson and Primm 1994). As the population of the area increased, more settlers were forced to settle the uplands (Ryan and Smith 1991). Fenced pasture began to replace the practice of open range. These two factors reduced the use of fire on the uplands thus decreasing the grassland and savanna type land cover (Ryan and Smith 1991; Jacobson and Primm 1994). The population of the area remained sparse until the large-scale exploitation of the vast timber resources of the region began in the late 1800's.

The virgin forests of the Ozarks remained relatively undisturbed by logging until the late 1800s (Cunningham and Hauser 1989). Part of the reason for this was due to the rugged nature of the topography which made railroad construction (one of the main means of lumber transport) a less feasible proposition than in other less rugged areas of the country. However, as the forest resources of the Eastern United States were depleted and more settlers began moving onto the sparsely forested western plains, the demand for lumber in the Ozarks increased. Undoubtedly, the cheap price of land having uncut timber was also very attractive to eastern speculators. In some instances, uncut timber land often sold for $1.00 an acre (Cunningham and Hauser 1989). This led to the construction of railroads in the region in the 1800s. Initially, the distribution of the first extensive commercial timber cutting in the Ozarks was limited by the distribution of shortleaf pine and transportation routes provided by rivers and railroads (Jacobson and Primm 1994). Shortly thereafter; however, the exploitation of hardwood species began. Larger shortleaf pine trees were harvested for lumber, while a variety of sizes of hardwood trees were harvested for products such as railroad ties, charcoal, barrel staves, and flooring (Rafferty 1983, Cunningham and Hauser 1989). The many different products produced from the timber of the Ozarks resulted in a wide range of species and sizes harvested. The population of the area sprang up as did several lumber towns including some within or bordering the Jacks Fork Watershed such as West Eminence, Birch Tree, and Winona.

Along with the eastern-backed lumber companies came the logging practices that had decimated much of the forests of the Eastern United States. These "cut and get out “operations, as they have been referred to in Cunningham and Hauser (1989), paid little or no attention to forest regeneration; focusing only on feeding the gigantic lumber mills located in the area. Williams (1904) states that the mill of the Ozark Land and Lumber Company at Winona, whose lumber stock covered 30 acres, had a production capacity of 140,000 board feet per day. With little or no attempt to reforest cut-over areas, land which had previously been dominated by pine and mixed pine oak forest began to regenerate to thick oak sprouts (Nigh 1988).

As the logging industry began to decline in the area, residents turned increasingly toward farming the rugged cut-over land in an attempt to carve out a means of survival. This is exemplified by a peak occurring between 1899 and 1920 in the acres cultivated for corn as shown in Figure Lu01. In addition, lumber companies as well as land speculators, eager to dispose of taxable cut-over land, began to offer the land for sale through nationwide advertising (Rafferty 1983; Cunningham and Hauser 1989). In many instances the land was advertised as being more productive than what it actually was (Cunningham and Hauser 1989). In 1904, the counties of Howell and Texas had approximately 154,000 acres (26%) and 185,681 acres (25%) respectively under cultivation (Williams 1904). Williams (1904) states that Shannon County had 50,665 acres of "improved farmlands" in 1904. Estimates of 1899 cropland within Howell, Shannon, and Texas Counties indicate combined harvested acres of wheat and corn were 73,021; 25,790 and 77,045 respectively (Table Lu01) (MASS 1999). This type of land use would have

undoubtedly contributed significantly to erosion and thus sedimentation and an increased gravel load in the streams of the regions watersheds such as the Jacks Fork.

As the century progressed, much of the area was found to be unsuitable for large scale row-cropping. This is illustrated in the relatively rapid decline during the first half of the Twentieth Century of the acres of corn harvested in Howell, Shannon and Texas Counties (Figure Lu01). As row crop farming began to decline, livestock farming became more prevalent (Figure Lu02). The 1930s saw an increase in livestock numbers of all three counties. Livestock numbers in Shannon County peaked in 1940 at approximately 40,400 head; while livestock numbers in Howell and Texas County continued to increase peaking at 130,200 (1980) and 107,000 (1994) respectively. The state and federal government began purchasing land in the area in the 1930s (Nigh 1988). Initial natural resource development was accomplished by the Civilian Conservation Corps (CCC); a work program of the Great Depression. Thus, began the era of natural resource management in the area.

In an effort to determine the effects of land use changes on stream disturbance in the Ozark Region, Jacobson and Primm (1994) evaluated present (1993) conditions of Ozark streams, pre-settlement period historical descriptions, stratigraphic observations, and accounts of oral-history responses on river changes during the last 90 years for the Jacks Fork River and Little Piney Creek Watersheds. This led Jacobson and Primm (1994) to the conclusion that Ozark streams are disturbed from their natural conditions. Jacobson and Primm (1994) state that this "disturbance has been characterized by accelerated aggradation of gravel, especially in formerly deep pools, accelerated channel migration and avulsion, and growth of gravel point bars". Jacobson and Primm (1994) also suggest that "land use changes have disturbed parts of the hydrologic or sediment budgets or both".

As part of the effort to determine the effects Jacobson and Primm (1994) summarized the land use changes from pre-settlement conditions to the 1970's in the Jacks Fork Watershed (Table Lu02).

"Different types of land use have taken place on different parts of the landscape, and at different times, resulting in a complex series of potential disturbances. Uplands have been subjected to suppression of a natural regime of wildfire, followed by logging, annual burning to support open range, patchy and transient attempts at cropping, a second wave of timber cutting, and most recently, increased grazing intensity. Valley side slopes have been subjected to logging, annual burning, and a second wave of logging. Valley bottoms were the first areas to be settled, cleared, and farmed; removal of riparian vegetation decreased the erosional resistance of the bottom lands. More recently, some areas of bottomland have been allowed to grow back into forest. The net effects of this complex series of land-use changes are difficult to determine and separate from natural variability."

Jacobson and Primm (1994) offer the following observations which summarize the probable, qualitative changes to runoff, soil erosion, and riparian erosional resistance on parts of the Ozarks landscape relative to man’s impact (Table Lu03):

1. Initial settlement of the Ozarks may have initiated moderate channel disturbance because of decreased erosional resistance of cleared bottom lands. This trend would have been countered by decreased annual runoff and storm runoff that accompanied fire suppression in the uplands.
2. Because of low-impact skidding methods and selective cutting during initial logging for pine during the Timber-boom period, logging would have had minimal effects on runoff and soil erosion.

3. Low-impact methods and selective cutting continued to be the norm in timber harvesting of hardwoods until the late 1940's, when mechanization and diversified markets for wood products promoted more intensive cutting. Locally, log and tie jams, tie slides, and logging debris may have added to channel instability by diverting flow, but because aggradation and instability also occurred on streams not used for floating timber, these factors were not necessary to create channel disturbance.
4. Significant channel disturbance probably began in the Timber-boom period because of continued clearing of bottom land forests and road building in the riparian zone. This hypothesis is supported by evidence that significant stream disturbance began before the peak of upland destabilization in the post-timber-boom period. Extreme floods during 1895 to 1915 may have combined with lowered erosional thresholds on bottom lands to produce the initial channel disturbance.
5. The regional practice of annual burning to maintain open range had the most potential to increase annual and storm runoff and soil erosion because of its considerable areal extent and repeated occurrence. Burning would have been most effective in increasing runoff and erosion on the steep slopes that had been recently cut over during the timber boom. Generally, accelerated soil erosion was not observed after burning, and relict gullies presently (1993) are not apparent on valley-side slopes and uplands. These observations support the hypothesis that burning did not produce substantial quantities of sediment.
6. The greatest potential for soil erosion on valley slopes and upland areas occurred during the
7. post-timber-boom period when marginal upland areas were cultivated for crops. Accelerated erosion of plowed fields was observed and noted by oral-history respondents and by soil scientists working in the Ozarks during the post-timber-boom period.
8. Valley bottoms have the longest history of disturbance from their natural condition because they were the first to be settled, cleared, and farmed. The lowered resistance to stream erosion that results from removing or thinning riparian woodland would have been a significant factor, especially on small to medium sized streams for which bank stability and roughness provided by trees are not overwhelmed by discharge. Disturbance of bottom land riparian forest increased as free-range grazing, crop production, and use of valley bottoms for transportation expanded and reached a peak in the post-timber-boom period. Headward extension of the channel network because of loss of riparian vegetation may have increased conveyance of the channel network (and hence flood peaks downstream) and removed gravel from storage in first and second order valleys at accelerated rates. This hypothesis is supported by a lack of other source areas for gravel and by observations that gravel came from small stream valleys, not off the slopes.
9. During present (1993) conditions, channel instability seems somewhat decreased in areas where the riparian woodland has recovered, but stability is hampered by high sedimentation rates because of large quantities of gravel already in transport and effects of instability in upstream reaches that lack a riparian corridor.
10. Land use statistics indicate that the present trend in the rural Ozarks is toward increased populations of cattle and increased grazing density. This trend has the potential to continue the historical stream-channel disturbance by increasing storm runoff and sediment supply and thus remobilization of sediment already in transit."

Human populations in Howell and Texas Counties have experienced relatively similar trends since the turn of the century with both experiencing an increase since 1970 (Figure Lu03) (OSEDA 1998).

However, the population of Howell County experienced an overall increase in population between 1900 and 1990, while the population of Texas County was slightly less in 1990 than 1900. The population of Shannon County experienced a sharp decrease after 1940 from which it has never recovered.

The 1990 human population within the Jacks Fork Watershed was estimated to be 6,621 (Blodgett J. and CIESIN 1996). Population density in 1990 was approximately 15 persons per square mile as compared to the overall population density for Missouri which was approximately 73 persons per square mile (Figure Lu04). Of course, one must take into account the effect of the state's urban centers on this estimate.

Projections of human population increase of Missouri counties have been calculated by the Missouri Office of Administration (MOA), Division of Budget and Planning for three different projection scenarios in a report entitled "Projections of the Population of Missouri Counties By Age, Gender, and Race: 1990 to 2020" (http://www.oa.state.mo.us/bp/popproj/index.htm)(MOA 1994). Combined population estimates for Howell, Shannon, and Texas Counties from 1990-2020 have been used to calculate percent increase in population for all three scenarios. The scenarios project a combined population increase of 9% to 26% by the year 2020.

Ecological Classification

The Ecological Classification System (ECS) is a management tool which provides a means of "describing distribution of current and potential natural resources in a manner that considers land capability upfront" using a knowledge of landform, geology, soils, and vegetation patterns (MDC 1997a). There are several levels of classification within the ECS. For purposes of this document the three lowest levels are dealt with. These levels are, in descending order, section, subsection, and land type association (LTA). The Jacks Fork Watershed lies within the Ozarks Highlands Section and intersects two subsections and 9 LTAs. The Ozark Highlands Section consists of very old and highly weathered plateaus which, coupled with its physiographic diversity and central geographic location relative to the continent, has created a region of unique ecosystems harboring many endemic species.

The subsections intersected by Jacks Fork Watershed include the Current River Hills, and the Central Plateau. The Current River Hills Subsection;

> *"encompasses the hilly to rugged lands associated with the Current, Jacks Fork, and Eleven Point River Valleys. These valleys have primarily cut through Roubidoux sandstone/dolomite, and Gasconade or Eminence dolomites. Soils are mainly deep and very cherty, but vary in depth, amount of chert and depth to clays. Original vegetation consisted largely of oak and oak-pine woodland and forest with scattered glades and savannas. Streams are both losing and gaining. Gaining reaches are often spring-fed and moderate to relatively high gradient" (MDC 1997a).*

The Central Plateau Subsection;

> *"represents the high, flat to gently rolling plains that are the least eroded remnant of the Salem Plateau. Underlain primarily by Jefferson City-Cotter dolomites or Roubidoux sandstone/dolomite, the plains are often mantled in a thin layer of loess and have droughty soils. Streams are mainly intermittent, low gradient headwater streams that are often losing. Savannas and woodlands were originally the dominant vegetation types" (MDC 1997a).*

Land Type Associations (LTAs) represent the smallest level of the three levels previously mentioned. LTAs intersecting the Jacks Fork Watershed include the following:

- Upper Gasconade Oak Woodland Dissected Plain

- Mtn. View Oak Savanna/Woodland Plain
- Summersville Oak Savanna/Woodland Plain
- Current River Oak-Pine Woodland Forest Hills
- Current-Eleven Point Pine-Oak Woodland Dissected Plain
- North Fork Pine-Oak Woodland Dissected Plain
- Current River Oak Forest Breaks
- Jacks Fork River Oak-Pine Forest Breaks
- Eminence Igneous Glade/Oak Forest Knobs

Table Lu04 gives descriptions of LTAs within the watershed.
The Ecological Classification System (Figure Lu05) could prove to be a useful tool for planning and implementing management activities by providing an indication of what natural resource management options will be more adapted to specific areas thus increasing the success of management decisions as well as helping to ensure that management decisions are ecologically enhancing.

Current Land Use

The Missouri Resource Assessment Partnership (MoRAP) Phase 1 Land Cover Classification (1997) (morapmd.wpd) data indicates estimated combined forest/woodland cover within the Jacks Fork Watershed at 76.1% while grassland/cropland comprises 22.7% of the total land cover (Table Lu05, Figures Lu06 and Lu07). Combined forest/woodland cover is the most dominant land cover type in all but one of the drainage units. The Jam Up Creek Unit contains the highest percentage of combined grassland/cropland within the watershed at 52.0%. This unit also has the highest percentage of urban area at 13.7% due to the presence of the City of Mountain View. The Jacks Fork-Alley Unit has the highest percentage of combined forest/woodland cover at 91.5%

Soil Conservation Projects

There currently are no SALT, SALT AgNPS, EARTH, PL566, or 319 projects within the Jacks Fork Watershed.

Public Land

A knowledge of land ownership within a watershed is an important key to understanding various characteristics of a watershed as well as addressing related issues and concerns. Within the Jacks Fork Watershed, approximately 19% (55,330 acres) of land is under public ownership. (Tables Lu06 and Lu07; Figures Lu08 and Lu09). Approximately 73% (40,490 acres) of public land within the watershed is owned by the Missouri Department of Conservation. The majority of this land is included in three areas. These areas include Angeline Conservation Area (CA), Gist Ranch CA, and Rocky Creek CA which are 16,960 acres; 7,400 acres; and 15,753 acres respectively (within the watershed). The National Park Service owns approximately 9,860 acres within the watershed. In addition, the United States Forest Service and the State of Missouri own approximately 4,162 and 790 acres respectively. The public land within the watershed includes approximately 36.2 miles of permanent public stream frontage and 10 stream accesses.
Public land ownership within the Jacks Fork Watershed is not evenly distributed. Instead, most of the public land is concentrated in the lower, or more eastern half, of the watershed (Table Lu07 and Figure Lu09). Analysis of land ownership percentages within drainage units shows that three units contain no public land. These units are Pine Creek, Leatherwood, and Lower South

Prong. The Jacks Fork-Alley Unit contains the largest percentage of public land ownership at 57.8%; most of which is managed by the Missouri Department of Conservation.

Figure Lu01. Historical acreage estimates of corn harvested in Shannon, Howell, and Texas Counties (MASS 1999).

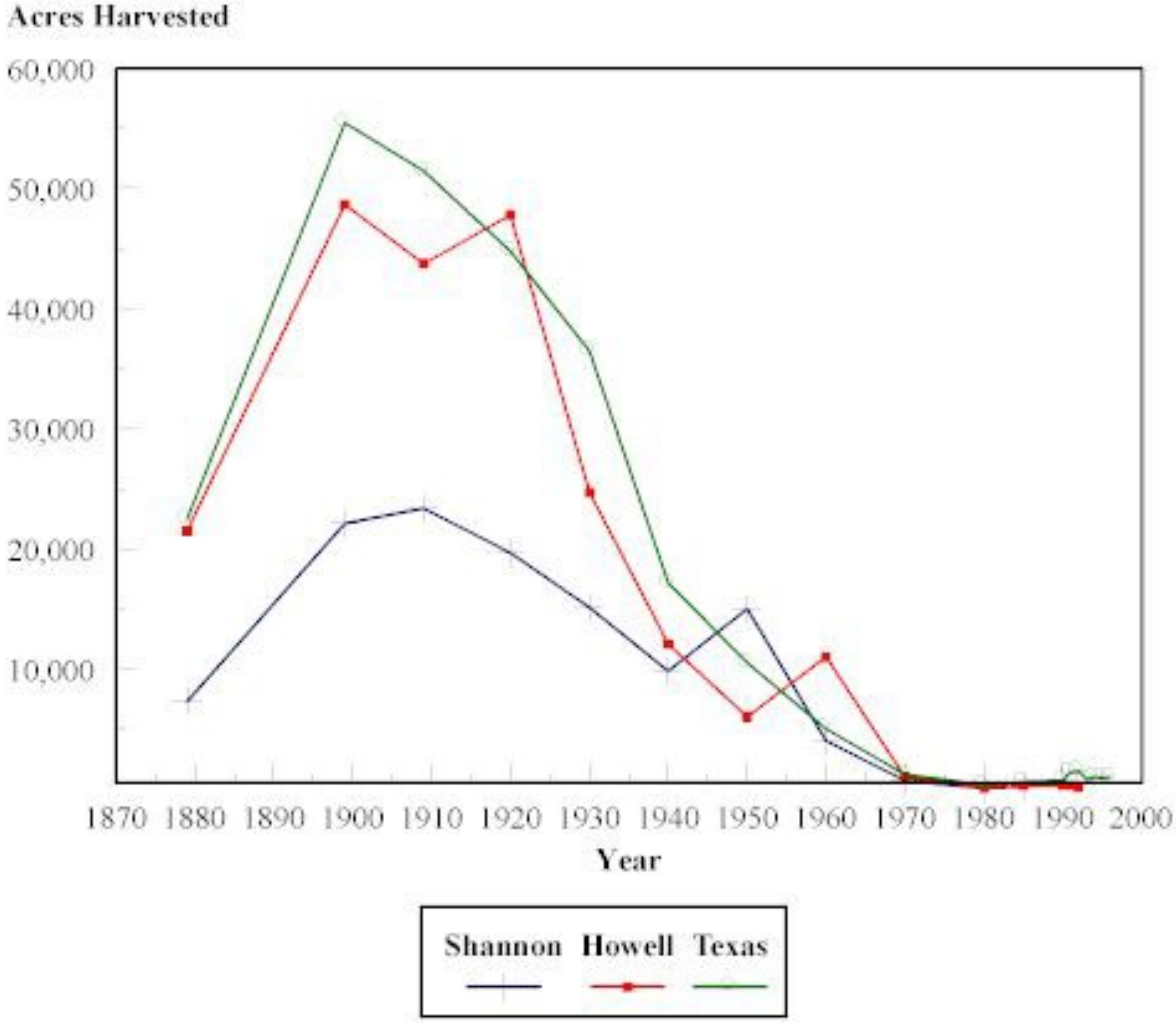
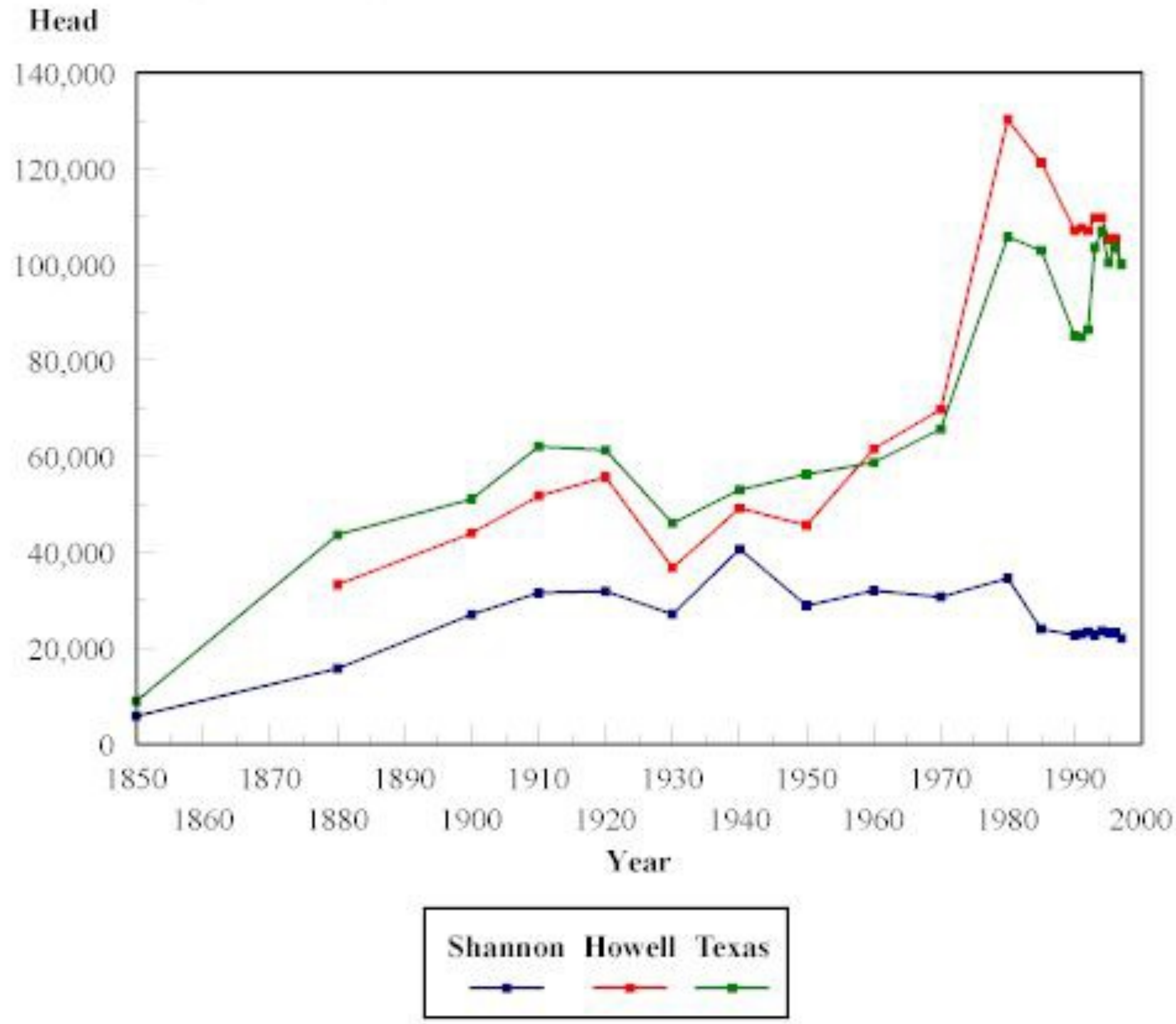


Figure Lu02. Cattle and hog population trends for Shannon, Howell, and Texas Counties (MASS 1999).



FigureLu03. Human population trends for Shannon, Howell, and Texas Counties (OSEDA 1998).

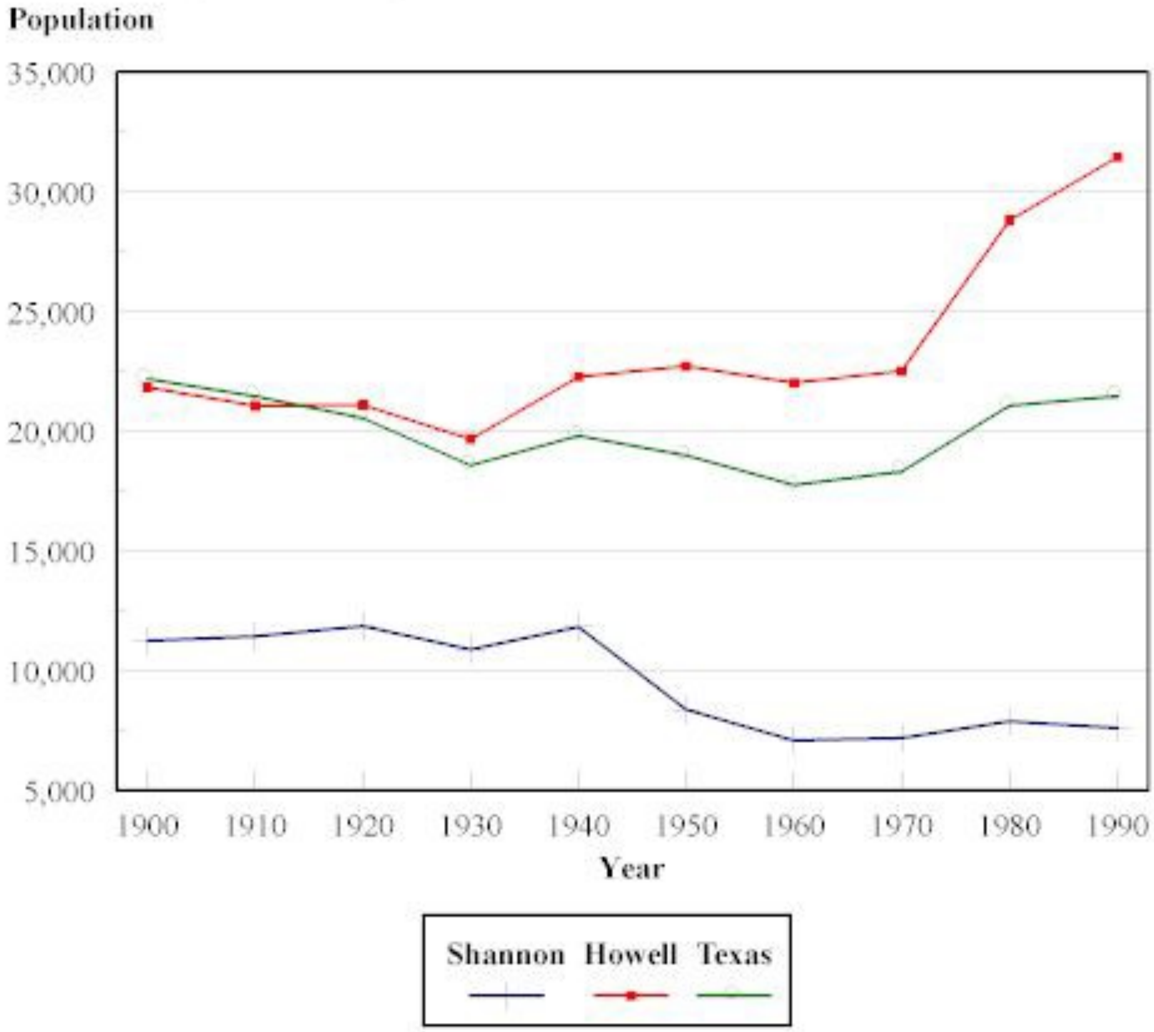


Figure Lu04.

Jacks Fork Watershed
Human Population

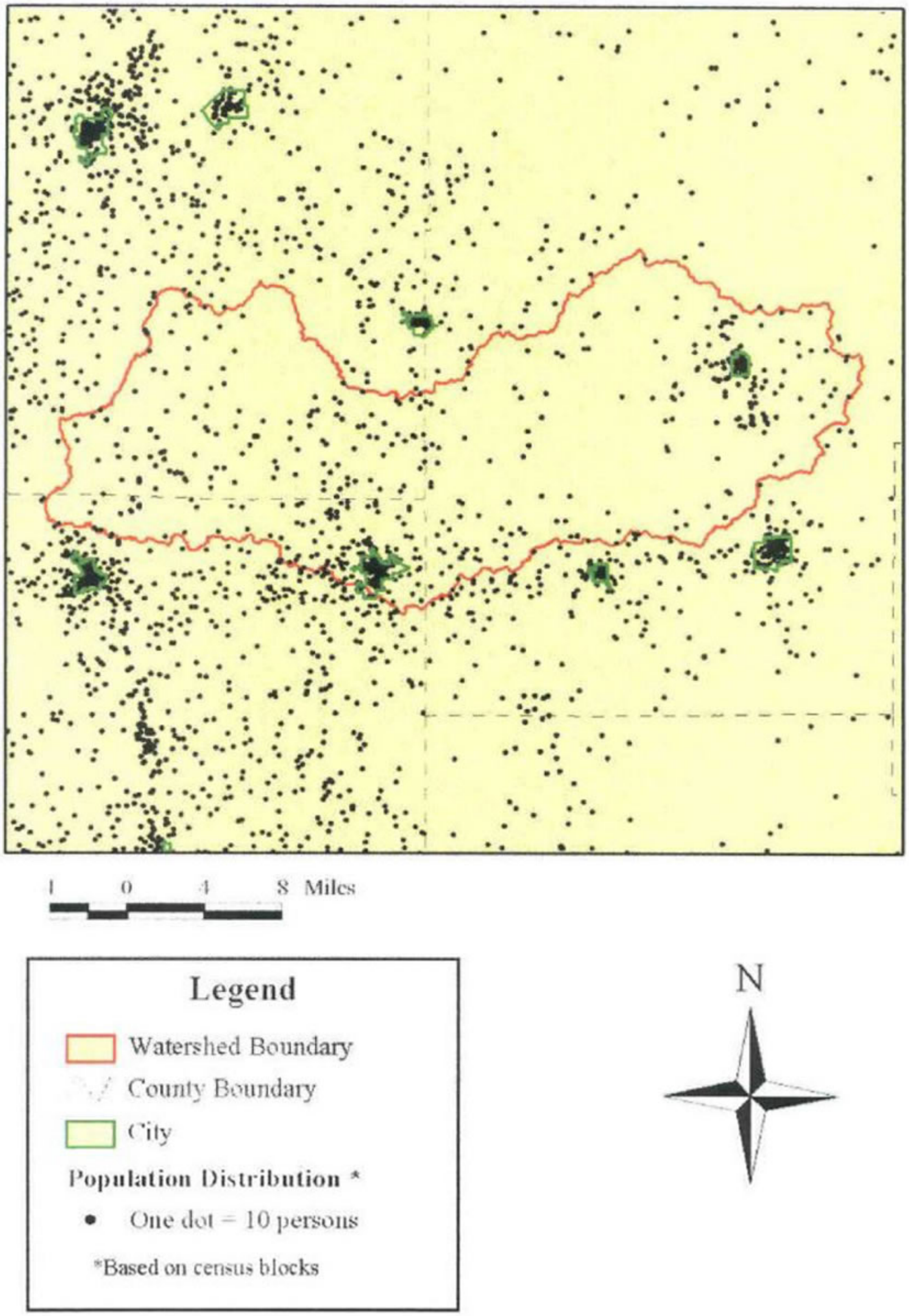
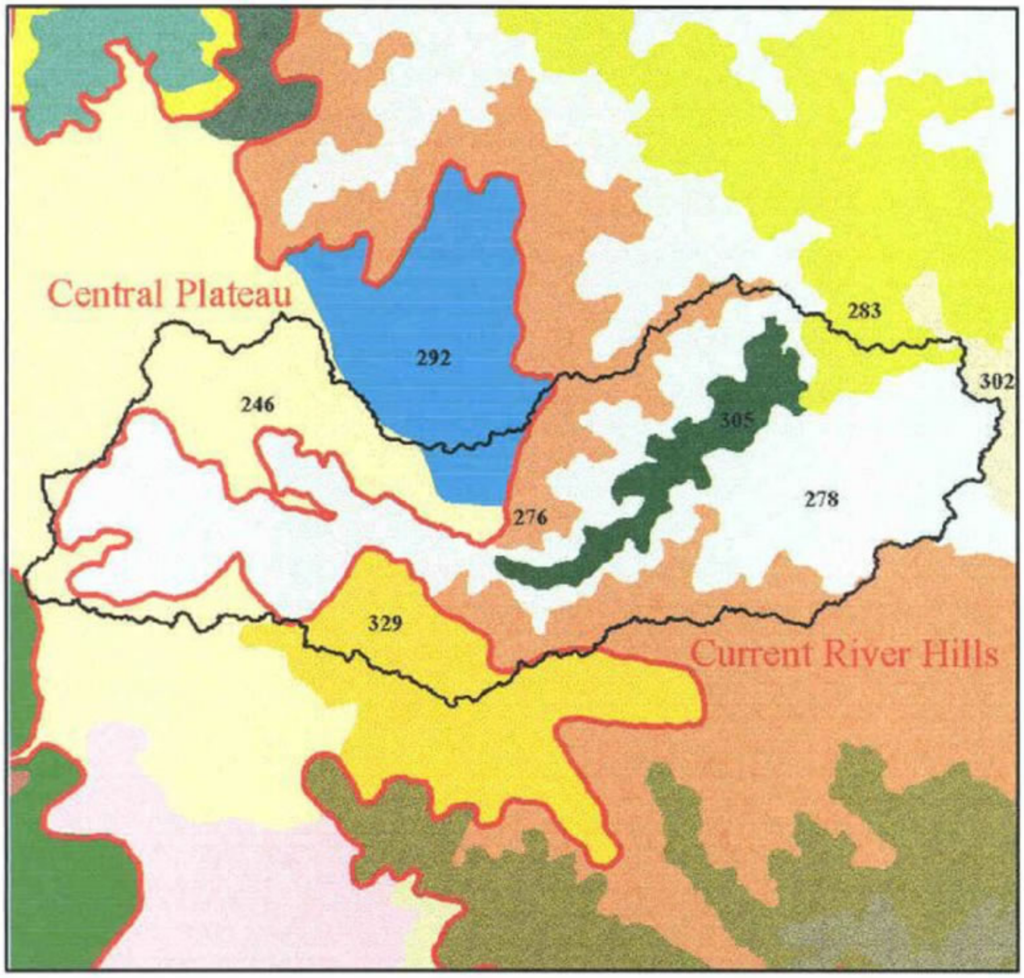


Figure Lu05.

Jacks Fork Watershed
Ecological Classification



Legend

- Watershed Boundary
- Ecological Subsection Boundary

Land Type Association

- Current River Oak Forest Breaks (283)
- Current River Oak-Pine Woodland/Forest Hills (278)
- Current-Eleven Point Pine-Oak Woodland Dissected Plain (276)
- Eminence Igneous Glade/Oak Forest Knobs (302)
- Jacks Fork River Oak-Pine Forest Breaks (305)
- Mt. View Oak Savanna/Woodland Plain (329)
- Summersville Oak Savanna/Woodland Plain (292)
- Upper Gasconade Oak Woodland Dissected Plain (246)

Based MoRAP (1997a)

Figure Lu06.

Jacks Fork Watershed
Land Cover/Land Use

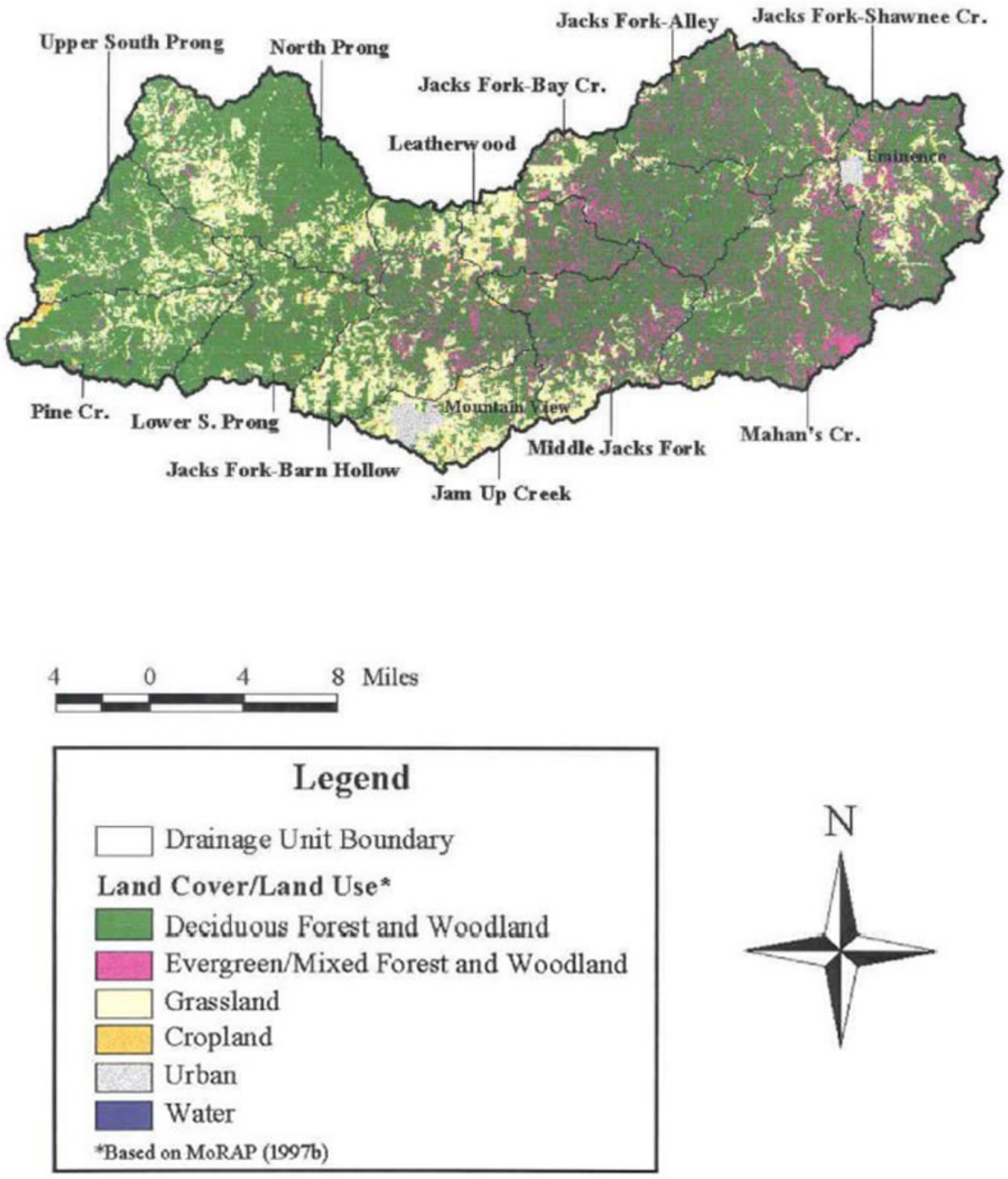


Figure Lu07.

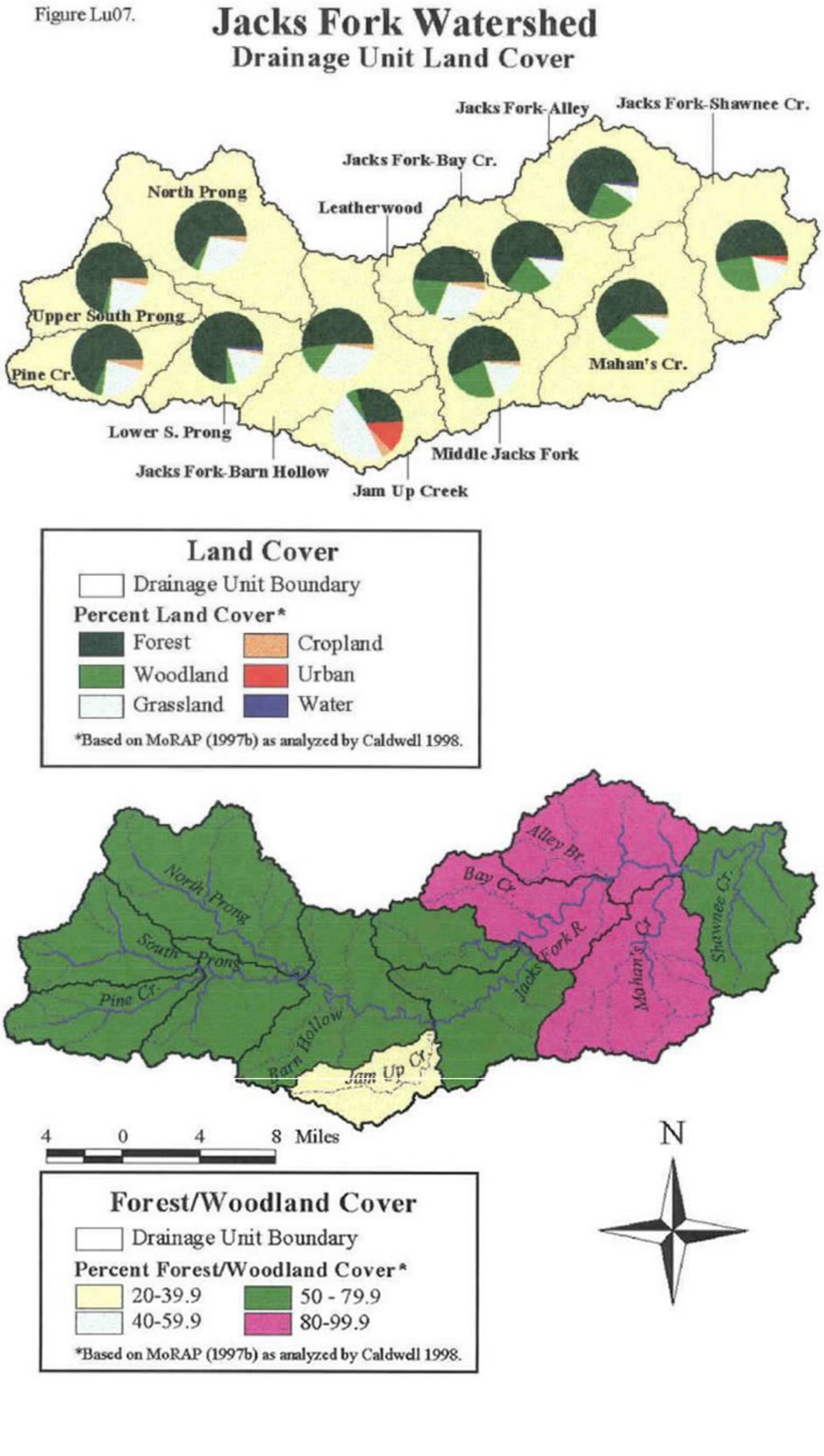
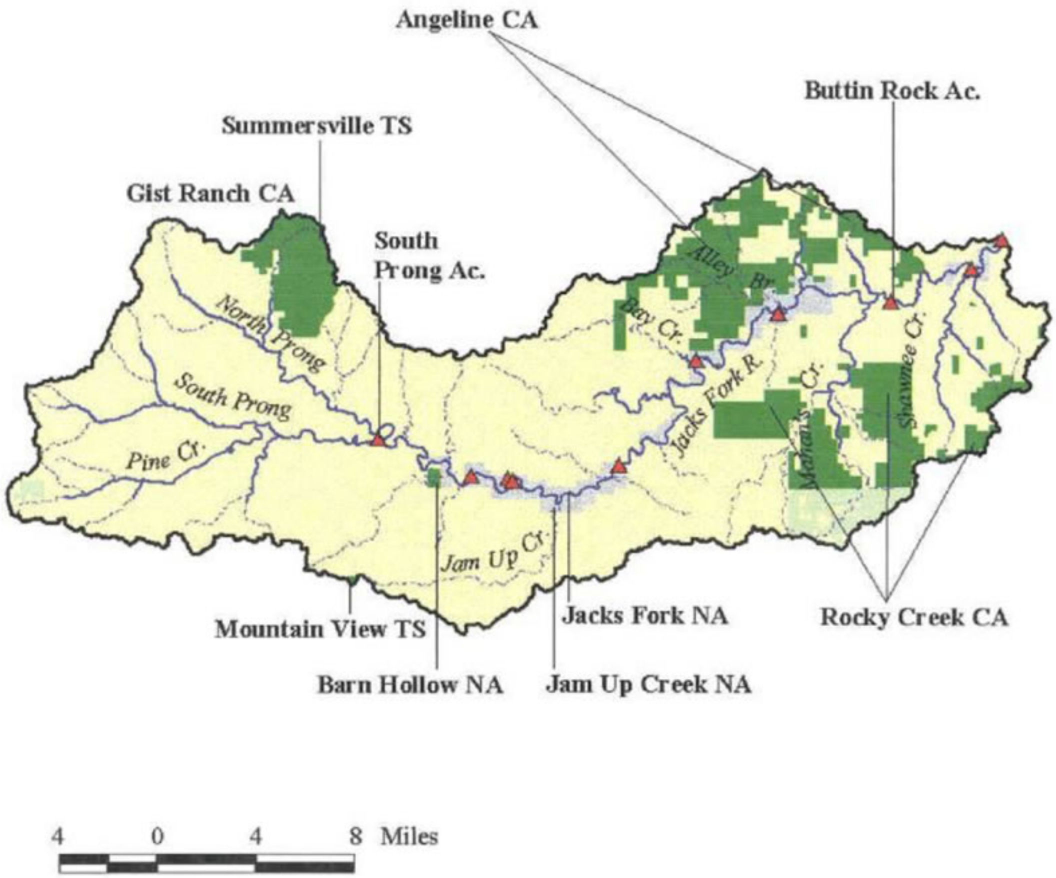

Jacks Fork Watershed
Drainage Unit Land Cover
Jacks Fork-Alley
Jacks Fork-Shawnee Cr.
Jacks Fork-Bay Cr.
North Prong
Leatherwood
Upper South Prong
Pine Cr.
Mahan's Cr.
Lower S. Prong
Middle Jacks Fork
Jacks Fork-Barn Hollow
Jam Up Creek
Land Cover
Drainage Unit Boundary
Percent Land Cover*
Forest
Cropland
Woodland
Urban
Grassland
Water
*Based on MoRAP (1997b) as analyzed by Caldwell 1998.
North Prong
South Prong
Pine Cr.
Barn Hollow
Jam Up Cr.
Alley Br.
Bay Cr.
Jacks Fork R.
Mahan's Cr.
Shawnee Cr.
4 0 4 8 Miles
N
Forest/Woodland Cover
Drainage Unit Boundary
Percent Forest/Woodland Cover*
20-39.9
50 - 79.9
40-59.9
80-99.9
*Based on MoRAP (1997b) as analyzed by Caldwell 1998.

Figure Lu08.

Jacks Fork Watershed
Public Land



Legend

- Watershed Boundary
- National Park Service
- Missouri Department of Conservation
- United States Forest Service
- Access
  (Only accesses which are not part of a larger area are labeled.)

Ac.-Access
CA-Conservation Area
NA-Natural Area
TS-Tower Site

Map is not a final Authority. Data Subject to Change

Figure Lu09.

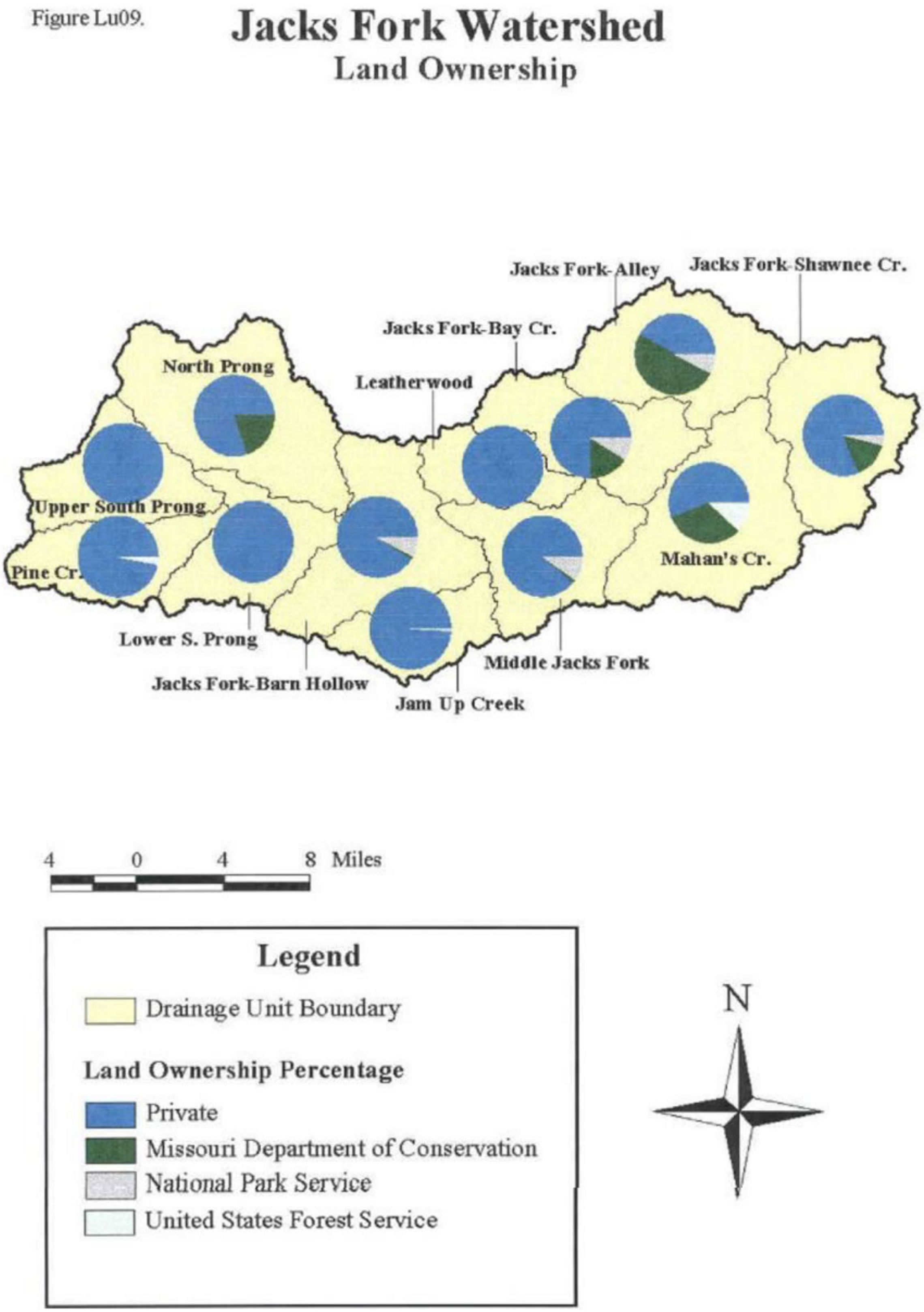

Jacks Fork Watershed
Land Ownership
Jacks Fork-Alley
Jacks Fork-Shawnee Cr.
Jacks Fork-Bay Cr.
North Prong
Leatherwood
Upper South Prong
Pine Cr.
Mahan's Cr.
Lower S. Prong
Middle Jacks Fork
Jacks Fork-Barn Hollow
Jam Up Creek
4 0 4 8 Miles
Legend
Drainage Unit Boundary
Land Ownership Percentage
Private
Missouri Department of Conservation
National Park Service
United States Forest Service
N

Table Lu01. Estimated acres of selected crops harvested in Howell, Shannon, and Texas Counties in 1899 and 1997 (MASS 1999).

—	Howell		Shannon		Texas	
	1899 Acres	1996 Acres	1899 Acres	1996 Acres	1899 Acres	1996 Acres
Corn	43,737	<500	22,122	<500	55,471	1,000
Hay	12,857	47,800	5,209	16,500	24,522	6,700
Wheat	29,284	<500	3,668	<500	21,574	<500

Table Lu02. Land cover/ land use change from pre-settlement period conditions (1820's) to the 1970's in the Jacks Fork Watershed, Missouri (Jacobson and Primm 1994).

1820's		1970's		%
Category	**Area sq. miles**	**Category**	**Area sq. miles**	
Shrub and Brush Rangeland	55.4	Urban/developed	1.6	3
		Pasture/cropland	26.5	48
		Deciduous forest	27.3	49
Deciduous Forest	242	Pasture/cropland	59.9	25
		Deciduous forest	178.6	75
Evergreen forest	3.5	Deciduous forest	3.5	100
Mixed forest		Pasture/cropland	34.5	11
	323.1	Deciduous forest	281.6	87
		Mixed forest	7	2
Barrens	29.2	Pasture/cropland	15.5	53
		Deciduous forest	13.7	47

Table Lu03. Summary of probable qualitative changes to runoff, soil erosion, and riparian erosional resistance on parts of the Ozarks landscape relative to pre-settlement period conditions. Reproduced in whole from Jacobson and Primm (1994).

Period Pre-settlement	Uplands Baseline	Valley Slopes Baseline	Valley Bottoms Baseline
Early Settlement			
Annual Runoff	Decrease	Slight Increase	N/A
Storm Runoff	Decrease	Slight Increase	N/A
Upland Sediment Yield	Decrease	Slight Increase	N/A
Riparian Erosional Resistance	N/A	N/A	Moderate Decrease
Timber-Boom			
Annual Runoff	Slight Increase	Slight Increase	N/A
Storm Runoff	Slight Increase	Moderate Increase	N/A
Upland Sediment Yield	Slight Increase	Moderate Increase	N/A
Riparian Erosional Resistance	N/A	N/A	Decrease
Post-Timber-Boom			
Annual Runoff	Moderate Increase	Increase	N/A
Storm Runoff	Moderate Increase	Increase	N/A
Riparian Erosional Resistance	N/A	N/A	Substantial Decrease
Recent			
Annual Runoff	Slight Increase	Slight Increase	N/A
Storm Runoff	Slight Increase	Moderate Increase	N/A
Upland Sediment Yield	Slight Increase	Slight Increase	N/A
Riparian Erosional Resistance	N/A	N/A	Decrease

Table Lu04. Descriptions of land type association (LTAs) groups as well as a condensed description of LTAs within the Jacks Fork Watershed. Descriptions are quoted in part or whole from MDC (1997).

Oak Woodland Dissected Plains and Hills Group

- **Landform:** Distinguished by rolling to moderately dissected topography. Local relief is 75-150 feet. Very broad, flat ridges give way to gentle side slopes and broad stream valleys. Karst plains with frequent shallow sinkhole depressions are common. Broad stream valleys most often occupied by losing streams, however occasional seeps do occur and can spread across substantial portions of a valley.
- **Geology:** Commonly underlain by Jefferson City-Cotter dolomites with a common loess cap. Some minor areas underlain by Roubidoux sandstones.
- **Soils:** Soils are variable, ranging from shallow to bedrock and fragipan soils, to deep, cherty and well-drained loams. Tree root growth is often restricted by bedrock, pans or clay mineralogy, especially high in the landscape.
- **Historic Vegetation:** Open woodlands with occasional prairie and savanna openings was the principal vegetation type. Post oak and black oak were the principal woodland tree species. Historic fire likely played an important role in maintaining an open canopy, sparse understory and a dense herbaceous ground flora. More dissected lands likely contained mixed oak woodland and forest. Unique sinkhole ponds, wet prairies and seeps were scattered in the broad valleys and depressions.
- **Current Conditions:** Currently a mosaic of fescue pasture (35-65% cover) and dense, often grazed oak forest. The transition from open grassland to closed forest is abrupt and the patch work blocky. Very few native grasslands or savannas are known, and the dense second growth woodlands have very little ground flora. Most sinkholes, wet prairies and seeps have been drained and heavily grazed. Many roads, towns, cities and businesses are located in these LTAs.
- **Upper Gasconade Oak Woodland Dissected Plain:** Broad divide encompassing the headwaters of the Big Piney and Gasconade River Watersheds.

Oak Savanna/Woodland Plains Group

- **Landform:** Very broad flat uplands slope gently to very broad flat drains or solution (karst) depressions. Local relief is less than 75 feet.
- **Geology:** Underlain mainly by Jefferson City-Cotter dolomites with a common loess cap. Minor areas of the Roubidoux formation occur. Headwater streams are nearly all losing.
- **Soils:** Fragipan soils or soils with shallow restrictive clays or bedrock are common, inhibiting tree root growth.
- **Historic Vegetation:** Oak savannas and woodlands with common prairie openings were the predominant historic vegetation. While few prairies were named by original land surveyors, early descriptions portray an open, "oak prairie" landscape. Fire likely played a principal role in maintaining a grassland-open woodland structure. Some sinkhole depressions would have had unique ponds and seeps.
- **Current Conditions:** The largest blocks and greatest acres of grassland (45-65% cover) are currently associated with these LTAs; grasslands are mainly fescue pasture. Less than 40% of these LTAs are timbered, mainly in dense, second growth oak forest (post and black oaks) with common grazing pressure. Very few quality native prairies, savannas, woodlands, sinkhole ponds or seeps are known. Many of the regions roads, towns, and businesses are associated with these LTAs.
- **Mtn. View Oak Savanna/Woodland Plain:** Broad, flat divide between upper Jacks Fork and Eleven Point Rivers.
- **Summersville Oak Savanna/Woodland Plain:** Broad, flat divide between Upper Current and Jacks Fork River.

Oak-Pine Woodland Forest Hills Group

- **Landform:** Mainly broad ridges, moderately sloping (<25%) side slopes, and relatively broad entrenched valleys with local relief between 150-250 feet. Steeper, more dissected areas occur locally near larger stream valleys. Sinkhole depressions are common on broader ridges. Stream valleys vary somewhat from broad and rather shallow, to more deeply entrenched, narrow, and meandering. Many losing streams occur in valleys distant from the main rivers. Cliffs, caves and springs are commonly associated with larger, perennial stream valleys.
- **Geology:** Roubidoux cherty sandstones and dolomites occupy most ridges and upper side slopes, while lower side slopes, especially near major streams are in cherty upper Gasconade dolomite materials.
- **Soils:** Soils are mainly deep, highly weathered and very cherty silt loams with clays at varying depth. Broad ridges may have a loess cap with occasional fragipans, and shallow soils with dolomite bedrock near the surface occur frequently on steeper, exposed slopes.
- **Historic Vegetation:** Pine and mixed oak-pine woodland originally dominated the more gently sloping upland surface associated with the Roubidoux Formation. Early descriptions portray an open, grassy and shrubby understory in these woodlands, a condition related to the prevalence of fire in the historic landscape. Oak and oak-pine forest occupied lower slopes and more dissected, hilly parts of these landscapes, as well as the wider and more well-drained bottom. Bottoms with richer alluvial soils and more abundant water likely were forested in mixed hardwood timber. Dolomite glade and open savanna/woodland complexes were common on exposed slopes with shallow soils. Sinkhole ponds and fens were dotted occasionally throughout.
- **Current Conditions:** Mainly forested in second growth oak and oak-pine forests; forest cover ranges from sixty to over 80%. Most forests are rather dense, near even-age second growth, with very little woodland ground flora. The occurrence of shortleaf pine in these forests has diminished from its original extent, today having only 20-30% of the forest cover containing a substantial component (>25%) of pine. Even age stands dominated by scarlet, black, and white oak are common, oak die back is a common problem. Much of the existing timber land is associated with public land ownership. Cleared pasture lands occupy many of the broad stream valleys and highest, flattest ridges. Many glades and woodlands suffer from woody encroachment, and sinkhole ponds and fens have been drained or severely overgrazed. An exceptional proportion of state-listed species sites are associated with the streams, springs, caves, cliffs, fens, and sinkhole ponds in this group.
- **Current River Oak-Pine Woodland Forest Hills:** Hills associated with the Current and Jacks Fork Rivers, excluding steep breaks.

Pine-Oak Woodland Dissected Plains

- **Landform:** Broad, flat to gently rolling plains which give way to moderately dissected and sloping lands associated with the headwaters of major drainages. Valleys are broad and local relief 100-150 feet. Clusters of karst sinkholes are common. Streams are mainly headwater streams with flashy, intermittent flow.
- **Geology:** Underlain by cherty sandstone and dolomite of the Roubidoux Formation with frequent loess deposits on the flatter uplands.
- **Soils:** Soils are formed principally in cherty sandstone and dolomite residuum from the Roubidoux Formation. Soils are mainly deep, cherty, and highly weathered, low base soils. However occasional fragipans and shallow to bedrock soils do occur. Most soils are extremely well drained and droughty.
- **Historic Vegetation:** Originally covered in woodlands of shortleaf pine and mixed pine oak with an open understory of dense grass and shrub ground cover. Post oak woodlands occupied occasional loess covered flats and unique sinkhole ponds dotted the landscape.

- **Current Conditions:** Over 75% of this group are currently forested in dense, even-age oak and oak-pine forest. Only 20% of these forests have a strong pine component. However, the proportion of forests containing shortleaf pine is the highest in this group. Dense stands of near even age scarlet, black, and post oak occur in the place of pine. Understories are dense, woodland ground flora sparse, and oak die-back common. A substantial component of these forested lands are publicly owned. Approximately 20% of this group is currently pasture, which often occupies the broad valley bottoms or karst plains. Most sinkhole ponds have been drained, dozed or severely overgrazed. Headwater streams are subject to grazing and bank erosion.
- **Current-Eleven Point Pine-Oak Woodland Dissected Plain:** High, flat to rolling divide between Current and Eleven Point Rivers; most extensive acreage of this group.
- **North Fork Pine-Oak Woodland Dissected Plain:** Flat to rolling landscape along the eastern edge of the North Fork Hills; uncertain boundary.

Oak and Oak-Pine Forest Breaks

- **Landform:** Distinguished by local relief over 300 feet, narrow ridges, steep side slopes and mainly narrow sinuous valleys. Cliffs, caves, and springs are common.
- **Geology:** Thick caps of Roubidoux Sandstone on ridges and upper slopes streams cut into the Lower Gasconade Dolomite.
- **Soils:** Soils formed from Roubidoux and Upper Gasconade materials.
- **Historic Vegetation:** Originally forested in oak pine, oak and mixed hardwood forest types. Scattered glades and open woodlands would have occurred on exposed slopes and ridges, especially in areas of shallow soil. Relatively small fen openings occasionally filled narrow tributary valleys.
- **Current Conditions:** A high percentage of public land (45%) is associated with this group. Because of the large amount of public land, as well as the steep topography, this group is still mostly forested (88%) in second growth oak, oak-pine and mixed hardwood timber. Open areas are confined to valleys, so bottomland forest is less than originally. Dolomite glades are largely overgrown with eastern red cedar, and many fens have been drained or heavily grazed. Numerous rare or endangered species, some restricted to this group, are associated with the streams, springs, caves, cliffs, and fens in these landscapes. The rivers have been recognized as national treasures and are an important recreational resource in the region.
- **Current River Oak Forest Breaks:** Cuts into Eminence dolomite. Consequently, unique benches occur on the Gunter sandstone, and extensive areas of more productive, higher base soils with oak and mixed hardwood communities occur here.
- **Jacks Fork River Oak-Pine Forest Breaks:** Extremely abrupt, narrow and sinuous valley with outstanding cliff communities, some harboring very unique flora.

Igneous Knobs

- **Landform:** Characterized by prominent, broadly rounded knobs which rise 500 to 600 feet above the middle Current River Valley. The knobs range from less than half to over 5 miles across and contain 58 distinct summits. Mainly broad, gently sloping knob tops give way to gentle to very steep sideslopes (10 to more than 35%). Narrow igneous shut-ins are common. Moderately broad, inter-knob basins with low gradient streams are often abruptly restricted by these shut-ins.
- **Geology:** The knobs are composed of Precambrian age rhyolite interconnected with Cambrian-age Eminence dolomite.
- **Soils:** Soils mainly consist of shallow to moderately deep and cobbly loams on the upper slopes and tops of the rhyolite knobs. Very deep, cherty silt loams predominate on the sedimentary areas between the knobs.
- **Historic Vegetation:** Extensive igneous glades and open oak woodlands encircled the tops of most knobs, while oak and oak-pine forests covered the side slopes. Scattered dolomite glades,

woodlands and fens were associated with shallow soils on the Eminence dolomite, sometimes filling low slopes and valley bottoms.

- **Current Conditions:** Igneous glades and open woodlands are largely overgrown with eastern red cedar, winged elm and other woody invaders. Over 90% of this LTA is forested in second growth oak and oak-pine timber. Much of the forest land is publicly owned. Clearing for pasture has occurred in the broader valleys (15% of LTA). Few high quality dolomite glades or fens are known.
- **Eminence Igneous Glade/Oak Forest Knobs:** The only LTA in this group.

Table Lu05. Percent land use for drainage units within the Jacks Fork Watershed. Data is based on MoRAP Phase 1 Land Cover (1997b) as analyzed by Caldwell (1998).

Unit	FOR	WDL	GRS	CRP	URB	WAT
Pine Creek	68.9	4.2	23	3.6	0	0.3
Lower South Prong	75.3	3.8	18.4	2.2	0	0.2
Upper South Prong	70.6	3.1	22.8	3.2	0	0.2
North Prong	66.4	3.7	28.1	1.6	0	0.1
Jack Fork-Barn Hollow	51.7	12.7	32.8	2.2	<0.1	0.6
Middle Jacks Fork	56.6	22.8	18.7	1	0	0.9
Jam Up Creek	29.7	4.5	47.3	4.7	13.7	<0.1
Jacks Fork-Bay Creek	65.4	21.7	11.2	0.8	0	0.9
Leatherwo od	48.5	20.4	27.5	3	0	0.5
Mahan's Creek	61.4	27.7	10.1	0.7	0	0.1
Jacks Fork-Alley	68.2	23.3	7.3	0.7	0	0.4
Jacks Fork-Shawnee	52.6	25.9	16.8	1.8	2.4	0.4
Watershed	60.8	15.3	20.8	1.9	0.8	0.3

FOR =Forest, **WDL**=Woodland, **GRS**=Grassland, **CRP**=Cropland, **URB**=Urban, **WAT**=Water

Table Lu06. Public lands within the Jacks Fork Watershed. For areas only partially within the watershed, total acreage is given in parenthesis.

Name	Owner[1]	Acres[2]	Permanent Stream (miles)[3]
Angeline CA	MDC	16,812.5 (37,246.1)	0.8
Barn Hollow NA	MDC	250.4	0
Buttin Rock Access	MDC	10.9	0.2
Jacks Fork NA	NPS	855.8	4.1
Jam Up Cave NA	NPS	149.1	0.5
Gist Ranch CA	MDC	7,400.9 (11,346.1)	0
Mountain View TS	MDC	30.8 (64.8)	0
Ozark National Scenic Riverways	NPS	8,854.70	28.3
Rocky Creek CA	MDC	15,709.6 (37,658.7)	0.2
South Prong Access	MDC	31.2	0.1
Summersville TS	MDC	31.2	0
Mark Twain National Forest	USFS	4,161.8 (7,056.4)	0
Total	-	55,330.5 (87,418.6)	36.2

Note: This table is not a final authority. Data subject to change.
[1]Owner: MDC=Missouri Department of Conservation NPS=National Park Service USFS=United States Forest Service
[2]Estimates are approximate.
[3]Estimates are approximate.

Table Lu07. Percentages of public land ownership within drainage units of the Jacks Fork Watershed.

Unit	MDC	NPS	USFS	Total
Pine Creek	0	0	3	3
Lower South Prong	<0.1	0	0	<0.1
Upper South Prong	0	0	0	0
North Prong	19.8	0	0	19.8
Jack Fork-Barn Hollow	0.5	8.4	0	8.9
Middle Jacks Fork	1	10	0	11
Jam Up Creek	0	0.9	0	0.9
Jacks Fork-Bay Creek	16	9	0	25
Leatherwood	0	0	0	0
Mahan's Creek	32.4	0	12	44.4
Jacks Fork-Alley	49.9	7.9	0	57.8
Jacks Fork-Shawnee	15.3	4	0	19.3
Watershed	14.1	3.6	1.6	19.3

MDC = Missouri Department of Conservation
NPS = National Park Service
USFS = United States Forest Service

Hydrology

Precipitation

The Jacks Fork Watershed is situated in one of the wetter parts of the state. Data available from the National Climatic Data Center (NCDC 1999) for 9 National Weather Service and cooperative stations located around the watershed, indicate an average annual precipitation of 43.21 inches for the period of 1936-1995. (Figure Hy01 and Hy02). The maximum recorded annual precipitation amount at an individual station during this period was 64.53 inches, while the minimum recorded annual precipitation during this period was 20.04 inches. Average annual precipitation in the watershed has increased over time. A comparison of average annual precipitation for two time periods 1936-1965 and 1966-1995, indicates an increase of 3.27 inches (8%) within the watershed. Figure Hy02 shows annual precipitation amounts as well as average annual amounts for the previously discussed time periods. Average monthly precipitation data for the period 1936-1995 indicates that the combined months of April, May, and June receive the most precipitation at 13.35 inches. The combined months of December, January, February receive the least amount of precipitation at 8.81 inches. Average monthly precipitation data for the period 1936-1995 indicates that May receives the most precipitation (5.01 inches) while January receives the least (2.61 inches) (Figure Hy03). Distribution of monthly precipitation amounts has shifted over time.

Average monthly precipitation comparisons between the periods 1936-1965 and 1966-1995 indicate an increase in precipitation in 9 of the months, while the remaining 3 months have experienced a decrease in precipitation. The most notable change has been an increase in the amount of average monthly precipitation occurring in the months of August, September, October, November, and December (Figure Hy04).

United States Geological Survey Gaging Stations

The United States Geological Survey (USGS) currently (1999) has three active stream discharge gaging stations within the Jacks Fork River Watershed (Table Hy01 and Figure Hy01) (USGS 2000a and USGS 2000b). Station #07066000 http://waterdata.usgs.gov/nwisw/MO/?statnum=07066000 is located on the Jacks Fork River 1.5 miles downstream from Mahan's Creek (USGS 1999a). The datum of the gage is 615.87 ft above sea level. Station #07066000 has been recording discharge data from October 1921 to the present. Station #07065495 http://waterdata.usgs.gov/nwis-w/MO/?statnum=07065495 is located on the Jacks Fork River 0.5 miles upstream from Alley Spring Branch. The datum of the gage is 652.74 ft above sea level. Station #07065495 has been recording discharge data from 1993 to the present. Station #07065200 http://rt02dmorll.er.usgs.gov/rt-cgi/gen_stn_pg?station=07065200 is located on the Jacks Fork River at Highway 17. The datum of the gage is 832.92 ft above sea level. Station #07065495 is a stage only station which has been recording data from 2000 to the present (Waite 2001).

In addition to the previously mentioned stations, historical discharge records exist from Station 07065500 (Alley Spring at Alley) for the periods of 1928-1939 and 1965-1979.

Daily Mean Discharge Statistics

Daily mean discharge statistics as well other long term hydrologic trends have been analyzed using data from gage station 07066000 (Jacks Fork at Eminence). This is because this station has

the most complete data set and longest period of record of any station within the watershed. It is also the most downstream station within the watershed.

The daily mean (average) discharge of the Jacks Fork at Eminence is 466 cubic feet per second (cfs) (2000a). The highest daily mean discharge at this station is 31,800 cfs which occurred on November 15, 1993 while the lowest daily mean discharge is 67 cfs which occurred on September 16, 1956. Analysis of historical discharge data available through the USGS National Water Information System (NWIS) (2000b) reveals that daily mean discharge has been lowest during the months of August, September, and October and highest during March, April and May (Figure Hy05). Comparison of two time periods, 1936-1965 and 1966-1995, indicates a significant increase in daily mean discharge between the two time periods. Station 07066000 has experienced an increase in daily mean discharge of 85 cfs (20%).

Comparison of percent change in precipitation (+8%) and daily mean discharge (+20%) would indicate that the increase of discharge in the latter time period is not entirely attributable to an increase in precipitation. Analysis of percent change in daily mean discharge by month between 1936-1965 and 1966-1995 indicate a substantial increase in all months except May, June, and July (Figure Hy04). The months of January and February show an increase in discharge and a decrease in precipitation. Possible explanations for contrasting changes between precipitation and discharge include a change in precipitation intensity, watershed land cover/land use, seasonal timing, duration and type (snow, rain, freezing rain) of precipitation, as well as the inherent inaccuracy associated with assigning point based precipitation measurements of varying spatial and temporal distribution to a relatively large surface area such as the Jacks Fork Watershed. The possible effects of land cover/land use change on runoff within the watershed is discussed in the Land Use/Land Cover Section of this document. However, due to a lack of quantitatively comparable (to current data) historic land cover/land use data, as well as the previously mentioned other factors, it is difficult to determine with reasonable certainty what role changing land cover has played in the shift to higher discharges. It is beyond the scope of this document to provide the necessary analysis of all factors which affect the hydrologic cycle. However, further research and analysis of these additional factors could prove useful in further determining long term hydrologic trends within the watershed in the future.

Flow Duration

Daily flow duration data for two time periods, available from the United States Geological Survey (USGS) Daily Values Statistical Program (DVSTAT) (2000c), was compared in order to determine flooding and/or drying trends of the Jacks Fork River. Figure Hy06 shows the duration of flows from 1936-1965 and 1966-1995 on the Jacks Fork River at Eminence. The flow duration curve from the latter time period shows an upward shift to higher discharges (Figure Hy06). The upward shift of the flow duration curve reflects an overall increase in discharge in the latter time period. The changes in the flow duration curve and discharge rates are an indication of possible changes in precipitation intensity, watershed land cover/land use, seasonal timing of precipitation, and duration and type (snow, rain, freezing rain, etc.) of precipitation. As stated previously, the area of the watershed has experienced an overall increase in average annual precipitation between the two time periods. In addition, seasonal timing of this precipitation has shifted, if slightly, between the two time periods (Figure Hy04). Land cover/land use changes within the watershed have also possibly had an effect on flow duration. However, the variability of land use/land cover data collection methodology and analysis, as well as the spatial and temporal variability of land cover changes make it difficult to reliably

determine actual quantitative land use/land cover changes which have occurred within the watershed for the previously discussed time periods. In addition, a lack of hydrologic data for the late 1800s and early 1900s leaves to speculation hydrologic trends prior to and through the "timber boom" period. As stated previously many factors exert influences on the hydrologic cycle. Analysis of all factors is beyond the scope of this document.
However, further data collection and analysis of hydrologic data will be important for determining long term trends within the watershed.

10:90 Ratio

The 10:90 ratio is used as an indicator of discharge variability. It is the ratio of the discharge which is equaled or exceeded 10% of the time to the discharge which is equaled or exceeded 90% of the time. It is useful for determining summer carrying capacity in streams as well as interbasin comparisons. The lower the 10:90 ratio the lower the variability of flow. The 10:90 ratio for the Jacks Fork at Eminence is 7:1.
This is a low value relative to 10:90 values of drainages of similar size within the state (Skelton 1976). This value is similar to 10:90 values from surrounding watersheds. Table Hy02 provides comparisons of 10:90 ratios from watersheds surrounding the Jacks Fork. The relatively low 10:90 ratios of the Jacks Fork and surrounding watersheds are due in large part to the water storage and release characteristics of the karst geology. It is, however, important to note that many streams within the area (most of which do not have discharge records) are "losing" in nature and thus will typically exhibit higher 10:90 ratios. An example of this is station 07070500 (Eleven Point River near Thomasville) which has a drainage area similar in size to the that of the Jacks Fork, but which has a high concentration of losing streams and a 10:90 ratio which is three times as great.

Instantaneous Discharge

Table Hy03 lists the highest and lowest instantaneous discharge rates that have occurred at Station 07066000 (Jacks Fork at Eminence, MO), Station 07055000 (Alley Spring at Alley, MO), and Station 07065495 (Jacks Fork at Alley Spring, MO).

7-day Q^2, Q^{10}, Q^{20} Low Flow and Slope Index

Q^2, Q^{10}, and Q^{20} seven day low flows refer to the lowest 7 day discharges that have a recurrence interval, on average, of 2, 10, and 20 years respectively. Some of the issues which low flow statistics help answer include the relative permanency of a stream and thus the streams ability to support aquatic life, the influence of groundwater in a particular watershed, as well as addressing issues related to effluent discharge. Seven day low flow statistics have been calculated for the Jacks Fork River at Eminence. The Jacks Fork River at Eminence has seven day Q^2, Q^{10}, and Q^{20} low flow values of approximately 122, 86, and 76 cfs, respectively. When analyzed relative to drainage area, these values are relatively similar to those of surrounding watersheds which, as a basic rule, tend to have the highest sustained low flows in Missouri (Skelton 1976).
The slope index (SI, ratio of the seven day Q^2 to Q^{20}) was calculated for the Jacks Fork River at Eminence for discharge data between 1936 and 1995. The SI was 1.6. This is a low slope index, an indication of low variability in annual low flows.

Flood Frequency

Table Hy04 indicates the frequency and magnitude of flooding on the Jacks Fork River at Eminence, Missouri (Station 07066000). Flood frequencies and magnitudes range from 11,900 cubic feet per second (cfs) with a frequency of two years to 102,000 cfs for a 500 year frequency (Alexander and Wilson 1995).

Figure Hy01.

Jacks Fork Watershed
Hydrologic Stations

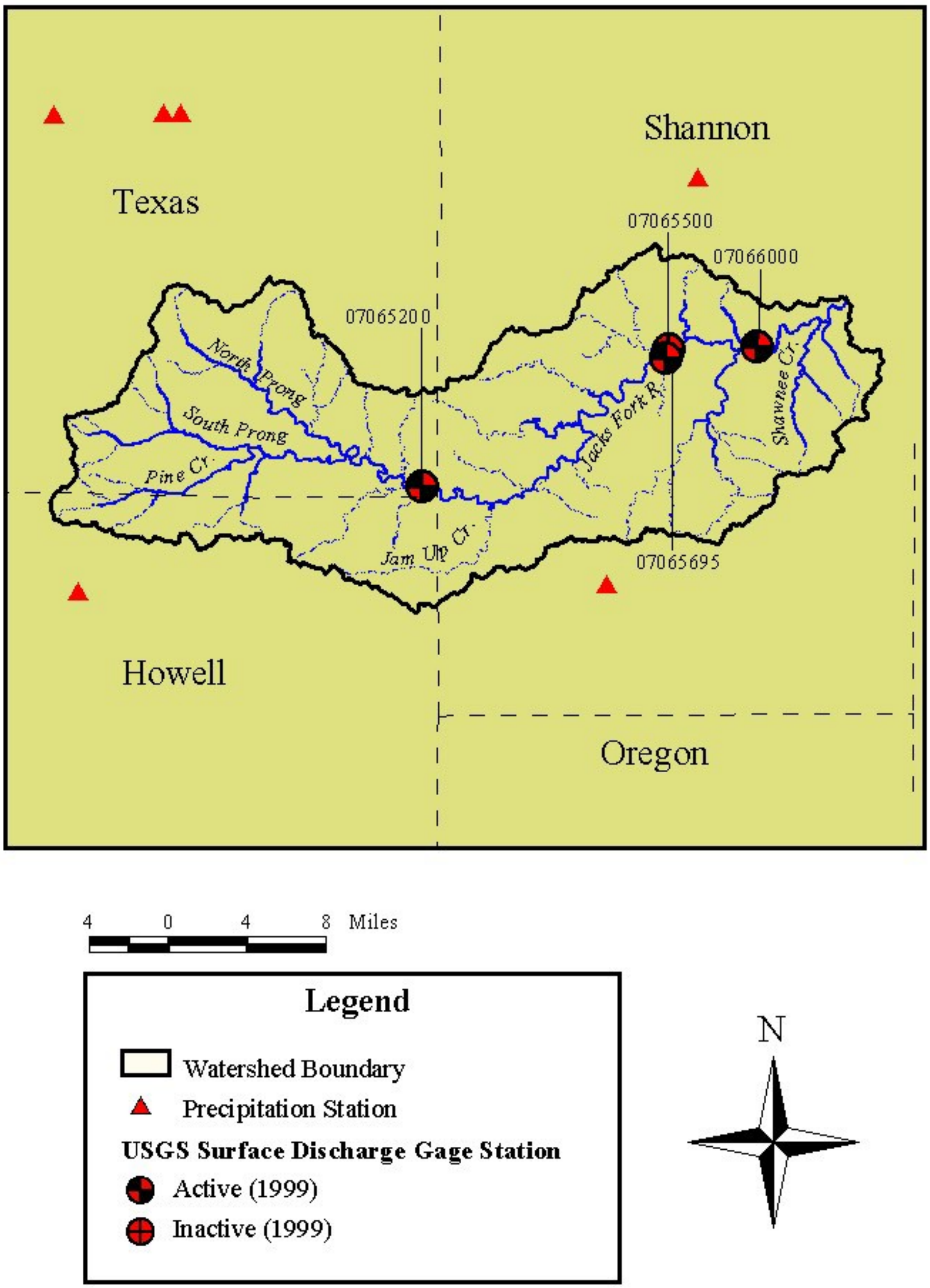


Figure Hy02. Mean annual precipitation amounts from National Weather Service and cooperative stations in the Jacks Fork Watershed area for years 1936-1995 (NCDC 1999). n=number of annual measurments available for period of record.

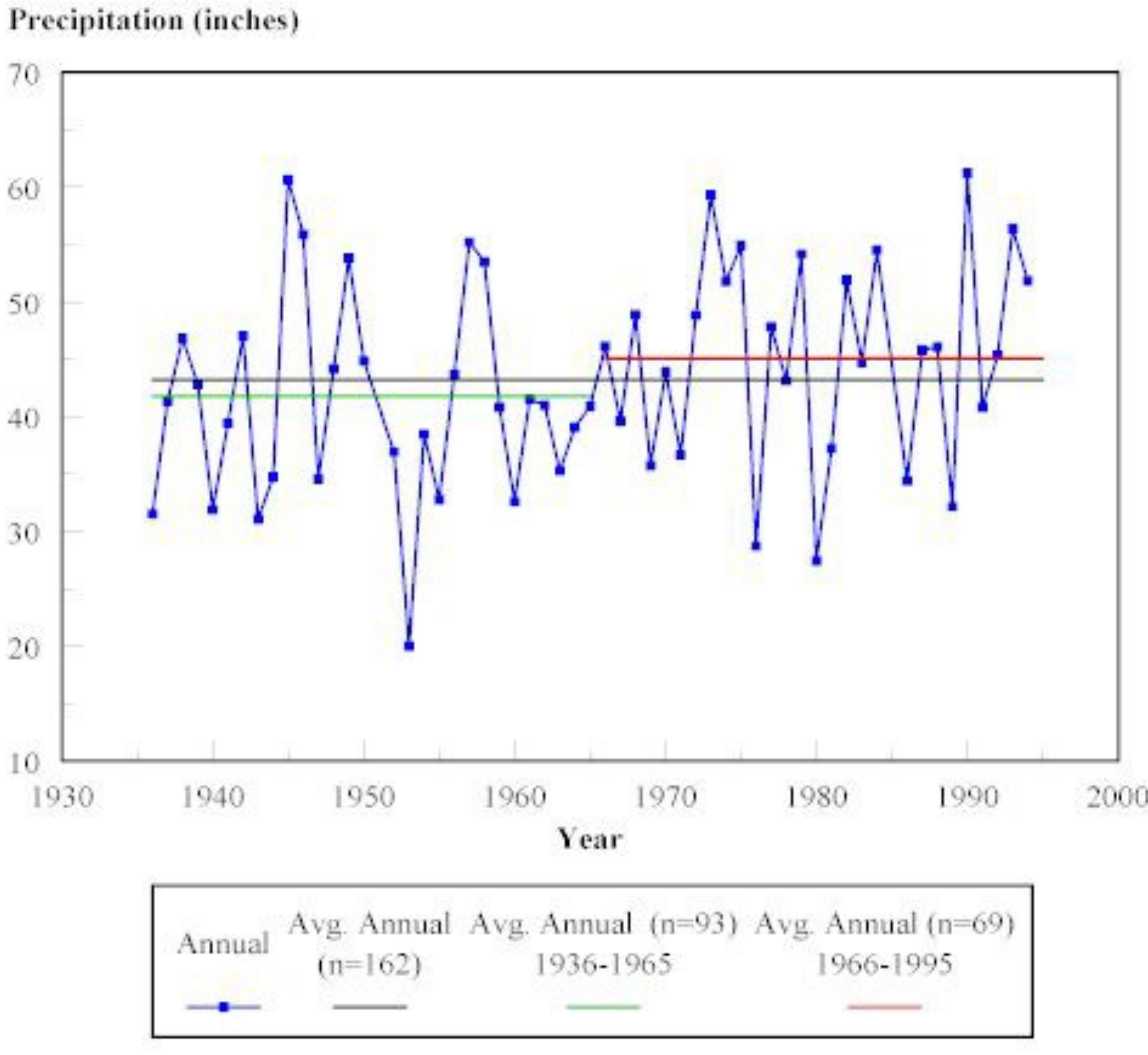


Figure Hy03. Mean monthly precipitation amounts from National Weather Service and cooperative stations in the Jacks Fork Watershed area (NCDC 1999).

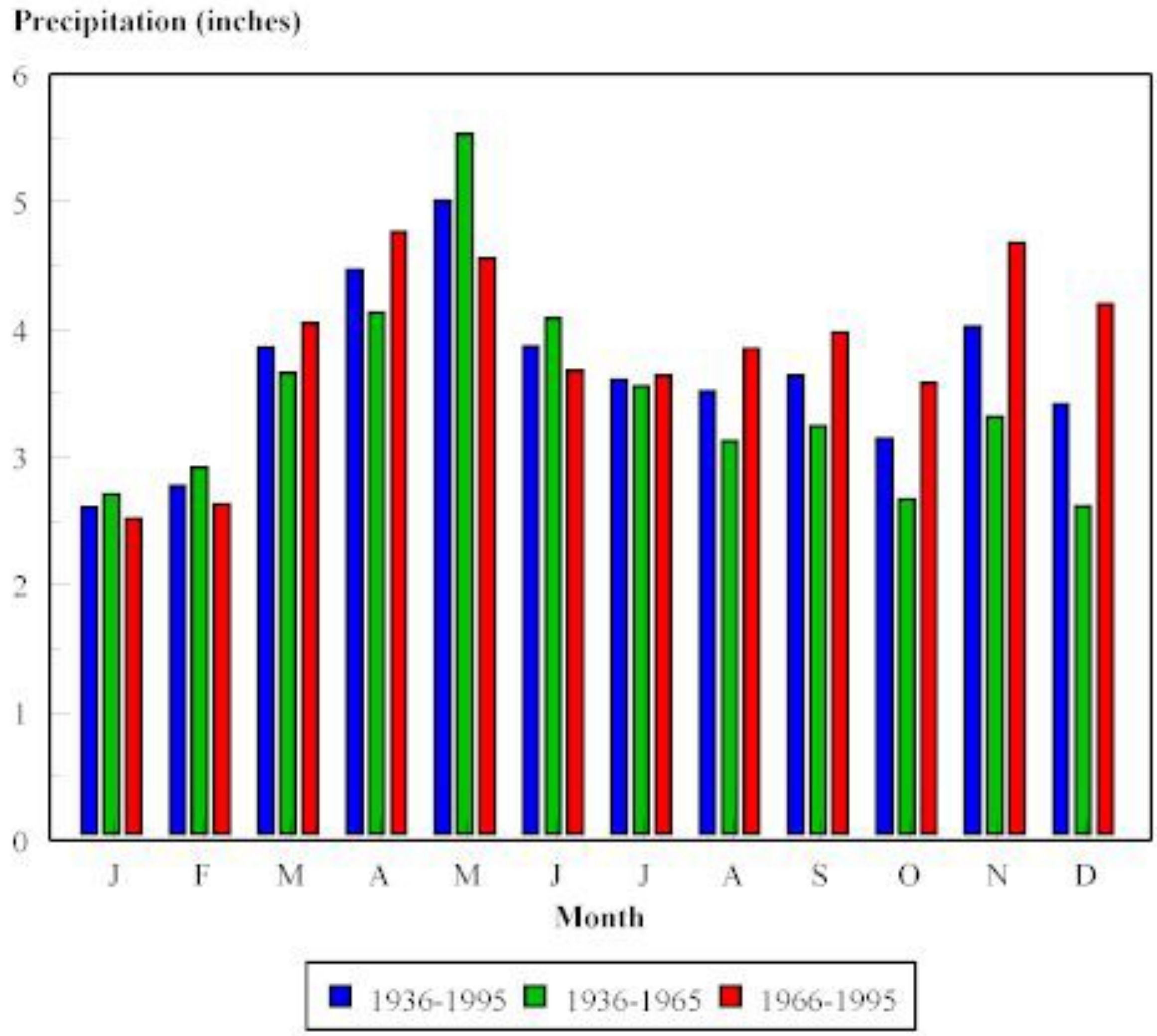


Figure Hy04. Change in daily mean discharge as well as precipitation by month between two time periods (1936-1965 and 1966-1995).

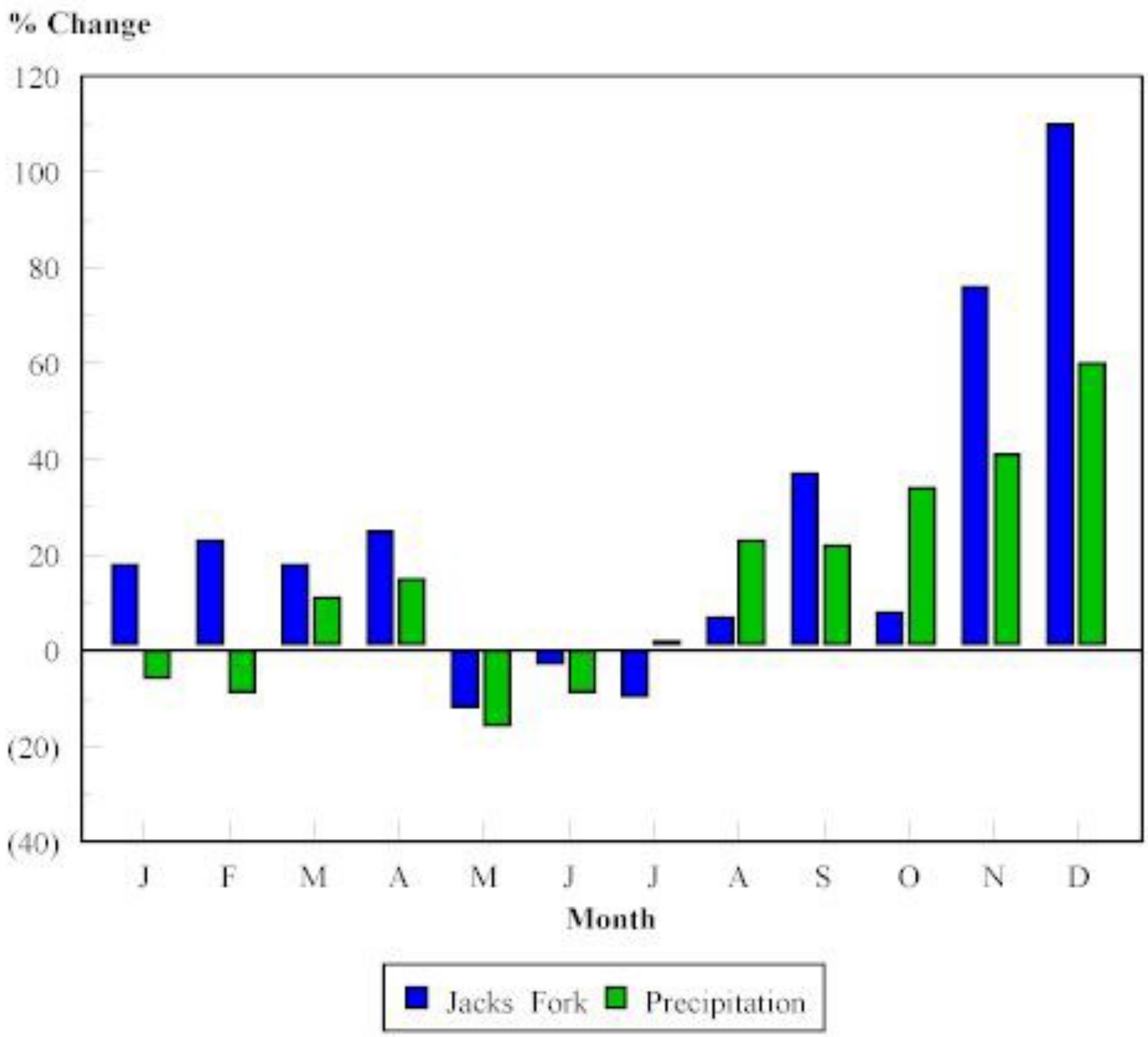


Figure Hy06. Flow duration changes between two time periods for Station 07066000 (Jacks Fork at Eminence) (USGS 2000c).

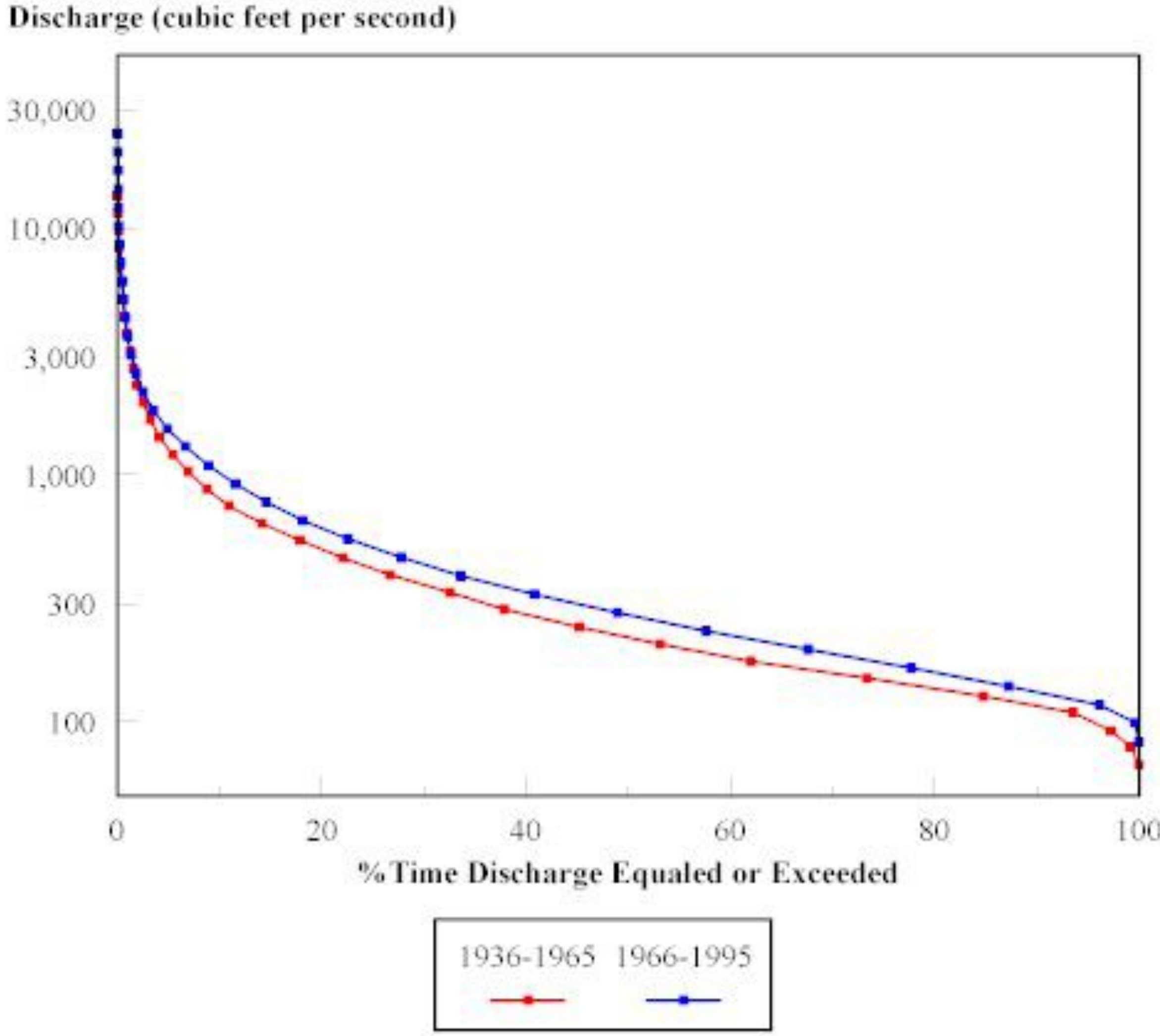


Table Hy01. United States Geological Survey surface discharge stations within the Jacks Fork Watershed (USGS 2000a).

Station #	Station Name	Drainage (mi^2)	Data Type	Period of Record
7066000	Jacks Fork at Eminence, MO	398	d.p.	1921-Present (1999)
7065500	Alley Spring at Alley, MO	-	d.p.	1928-1039 1965-1979
7065200	Jacks Fork near Mountain View	Not Available	s	2000-Present
7065495	Jacks Fork at Alley Spring, MO	298	d.p.	1993-Present (1999)

Record Type: d=daily discharge, p=peak flow, s=stage

Table Hy02. Comparison of 10:90 ratios from the Jacks Fork and surrounding watersheds (Skelton 1976).

Station #	Name	Watershed	Drainage Area	10:90
7066000	Jacks Fork at Eminence	Jacks Fork	398	6.8
7057500	North Fork River near Tecumseh	North Fork	561	4.6
7058000	Bryant Creek near Tecumseh	North Fork	570	6.9
7066500	Current River near Eminence	Current	1,272	5.5
7067000	Current River at Van Buren	Current	1,667	5
7068000	Current River at Doniphan	Current	2,038	4.1
7070500	Eleven Point River near Thomasville	Eleven Point	361	22.9
7071500	Eleven Point River near Bardley	Eleven Point	793	5.4
6930000	Big Piney River near Big Piney	Big Piney	560	8.3

Table Hy03. Discharge statistics for United States Geological Survey Discharge Gage Stations within the Jacks Fork Watershed (USGS 1999a and USGS1999b).

Station	Avg. (cfs)	Instant Peak Flow (cfs)	Max (cfs)	Instant Low Flow (cfs)	Min (cfs)
07066000 (Jacks Fork at Eminence, MO)	466	48500 11/15/1993	31800 11/15/1993	64 8/28/1936	67 9/16/1956
07065500(Alley Spring at Alley, MO)	134	NA	1060 3/11/1935	N/A	54 10/17/1934
07065495 (Jacks Fork at Alley Spring, MO)	308	48700 11/14/1993	23300 11/14/1993	52 9/11-15/1998	52 9/12/1993

Avg.=Average Daily Discharge
Max=Highest Daily Mean
Min=Lowest Daily Mean

Table Hy04. Magnitude of flood events (cubic feet per second) for selected recurrence intervals (years) at USGS Station 07066000 (Jacks Fork at Eminence) (Alexander and Wilson 1995).

Recurrence Interval (years)						
Site	2	5	10	25	50	100
Jacks Fork at Eminence	11,900*	24,200*	34,100*	48,200*	59,500*	71,500*

*cfs

Water Quality

Beneficial Use Attainment

Approximately 150 stream miles within the Jacks Fork Watershed classified with beneficial uses as defined in Table H of the Rules of the Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality (Table Wq01) (MDNR 1999a). These streams must meet or exceed established criteria as defined in Table A of the Rules of the Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality for those beneficial uses (MDNR 1999b). All watershed streams listed in Table H are designated for livestock/wildlife watering as well as protection of aquatic life. Two streams within the watershed have additional designated beneficial uses. These streams are The Jacks Fork and Mahan's Creek. Approximately 39 miles of the Jacks Fork (from its mouth to Township (T) 28n, Range (R) 07w, Section 29) is designated for livestock/wildlife watering, protection of aquatic life, cool water fishery, whole body contact recreation, and boating/canoeing. Approximately 4.0 miles of Mahan's Creek (from its mouth to T28n, R04w, Section 09) is designated for livestock/wildlife watering, protection of aquatic life, and cool water fishery (MDNR 1999a). In addition to the aforementioned designated uses, the Jacks Fork River has been designated as "Outstanding National Resource Waters" from its mouth to its headwaters (MDNR 1999a). No streams within the Jacks Fork Watershed are designated for use as a drinking water supply. The streams of this watershed have no public surface water withdrawals.

Section 303(d) of the Federal Clean Water Law requires that states identify those waters for which current pollution control measures are inadequate (MDNR 1999b). This is accomplished by comparing data from those waters with water quality criteria established for designated beneficial uses of those waters (MDNR 1999b). Waters that do not meet their criteria are then included in the 303(d) list. The state must then conduct Total Maximum Daily Load (TMDL) studies on those waters in order to determine what pollution control measures are required and then insure those measures are implemented (MDNR 1999c). Five miles of Jacks Fork River from T29n, R3w, section 9 to T29n, R4w, section 26 are currently included in the 1998 303(d) list (MDNR 1999d). In this section of the Jacks fork, fecal coliform counts are periodically high indicating the presence of excessive organic wastes. The Clean Water Act requires that the 303(d) list be updated every four years (MDNR 2000a).

Chemical and Biological Quality of Streamflow

Data regarding the chemical and biological quality of stream flow within the Jacks Fork Watershed has been collected by several different entities since the 1960s. Government agencies which have conducted water quality sampling within the watershed include the Environmental Protection Agency, Missouri Department of Conservation, Missouri Department of Natural Resources, National Park Service, and the United States Geological Survey. In addition, some water quality data has been collected by Stream Team organizations. The extensive amount water quality data available for various parameters and varying time periods within the Jacks Fork Watershed, makes an adequate summary of water quality data within this document, impractical.

In order to avoid going beyond the scope of this document by attempting to provide a comprehensive summary of all water quality data by all agencies for all available years, a single station within the Jacks Fork Watershed has been selected in order to provide a spatial and temporal snapshot of selected water quality values. USGS station 07066110 has been selected for

this purpose. Station 07066110 is located on the Jacks Fork River upstream from the mouth of Shawnee Creek at the Shawnee Campground (USGS 2000a). Water quality data has been collected at USGS Station 07066110 since 1973 (Figure Hy01 and Figure Wq01) (USGS 2000a). Table Wq02 lists selected water quality parameters and standards as well as maximum and minimum observations of selected parameters from station 07066110 for water years 1994-1998. Water quality at this station consistently met water quality standards for the selected parameters during the years examined with the exception of fecal coliform bacteria. Out of 31 observations conducted from 1994 to 1998, fecal coliform levels at station 07066110 exceeded state water quality standards for whole body contact recreation five times (Figure Wq02). All of these instances occurred during the recreational period, April 1-October 31 (as designated by MDNR 1999a). It is important to note that Station 07066110 is located on the section of the Jacks Fork River that is designated for whole body contact recreation. It is also notable that observed fecal coliform levels at station 07066110 did not exceed standards for whole body contact recreation during the 1998 water year. Water quality data also indicates that water at station 07066110 is hard as defined by the USGS (1999b)

As stated previously, a large amount of water quality data for a variety of parameters is available for the Jacks Fork Watershed. Microbiological sampling has been conducted within the Jacks Fork Watershed as part of a long term monitoring project cooperatively by the USGS, National Park Service, and the Missouri Department of Natural Resources (USGS 2001). Data is currently available for 35 sites with the number of samples at each site ranging from 1 to 55 http://missouri.usgs.gov/wtrqual/jf.htm. Water quality data is also available for additional parameters from the USGS Historical Water Quality Data Website http://wwwdmorll.er.usgs.gov/watdata/wtrqual/ and the annual USGS Water Resources Data Reports as well as the EPA Storage and Retrieval (STORET) Database http://www.epa.gov/storet/. In addition, volunteer water quality monitoring data is available from the Missouri Stream Team online database http://www.mostreamteam.org/vmsearch.html. Additional State Water Quality Standards are available in the most current document of the Rules of the Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality http://mosl.sos.state.mo.us/csr/10csr/10c20-7a.pdf.

USGS Pesticides National Synthesis Project

The United States Geological Survey conducted water quality samples within the Jacks Fork Watershed from 1993-1995 as part of the Pesticides National Synthesis Project in order to determine the spatial and temporal distribution of contamination by pesticides in the water resources of the United States (USGS 1999c). The Jacks Fork Watershed was part of the Ozark Plateaus Study Unit of the National Water Quality Assessment Program. One surface water sampling site and one ground water sampling site were selected within the watershed (Figure Wq02) (USGS 1999d and 1999e). A single sample was taken at the ground water sampling site in 1993. Four samples were taken between 1994 and 1995 from the surface water sampling site (USGS 1999f and 1999g). Pesticide compounds were detected in two of the four surface water samples. These compounds included Deethylatrazine, Thiobencarb, Atrazine, and Metalachlor. No pesticide compounds were detected within the single ground water sample. By comparison, 39 of 43 surface water sites within the Ozark Plateaus Study Unit had detections of pesticides with 18 sites having samples with six or more pesticide detections (Bell et al. 1997). In addition, 73 of 215 ground water sample sites within the Ozark Plateaus Study Unit had pesticide detections with a maximum of 5 pesticides detected in any one sample (Adamski 1996).

Ground Water Quality

The presence of karst features both within and around the Jacks Fork Watershed such as Jam Up Creek, a losing stream, increases the risk of ground water contamination from point and non-point sources of pollution located on the surface. Due to the fact that most of the watersheds population is rural, indicating that most receive their water from untreated private wells, the quality of surface water which has the potential to enter the groundwater system is important. In addition, portions of the permanent flow within the watershed are enhanced by springs. Thus, any contaminant which affects ground water quality is likely to affect surface water quality as well as drinking water quality. There are several ways in which contaminants can enter the groundwater system. These include losing streams, sinkholes, and abandoned wells. As indicated by dye traces performed within the watershed, ground water movement is not always restricted by surface watershed boundaries. Some groundwater does exhibit movement to other watersheds. The most notable example of this is groundwater movement from Jam Up Creek to Big Spring in Carter County.

Water quality tests performed by the Missouri State Public Health Laboratory in Springfield and Popular Bluff on 308 wells in Howell, Shannon, and Texas Counties from July 1998 to August 1999 indicate that 119 (38.6%) well samples tested were unsafe (Farmer, personal communication and Jones, personal communication). A well is considered unsafe if any coliform colonies result from the sample (Farmer, personal communication). Howell County had the highest percentage of unsafe wells with 40.6% of the wells tested in this group deemed as unsafe (Farmer, personal communication and Jones Personal Communication). It is important to note that other samples probably exist which are not included in these results. In addition, these results are inclusive of those portions of the counties mentioned which are outside the boundaries of the Jacks Fork Watershed. Many other variables such as spatial and temporal distribution of samples, as well as sample method variability, limit the use of this data. However, it can provide a rough insight into the ground water quality of the general area of the watershed.

Point Source Pollution

Table Wq03 lists 5 National Pollution Discharge Elimination System (NPDES) sites currently within the Jacks Fork Watershed (Figure Wq01) (MDNR 1998a). There are two permitted (by MDNR) municipal waste water discharges within the watershed. (MDNR 1998a). These serve the cities of Mountain View and Eminence. As of 1994, the Mountain View Waste Water Treatment Facility (WWTF) was discharging 0.250 million gallons per day (mgd) into Jam Up Creek; a losing stream. While the Eminence WWTF was discharging 0.292 mgd into the Jacks Fork River (MDNR 1994). Additional information regarding MDNR Water Pollution Control Program (WPCP) permitted facilities can be found at the WPCP permit website http://www.dnr.state.mo.us/deq/wpcp/wpcpermits.htm.

The Missouri Department of Natural Resources, Division of Geology and Land Survey has identified 13 active mines and 22 past producers within the Jacks Fork Watershed in Missouri (MDNR 1998b). All 13 current mines are gravel removal operations or limestone quarries. The highest percentage of past producers are copper and iron mines. Nearly all of these are surface mines which dot the watershed.

These open pits can act as a direct link to the ground water system and thus pose a threat to ground water quality if pollutants are allowed to enter. This can affect wells from which nearly all of the watersheds population receives its water. It can be assumed that many of these wells are shallow and/or untreated which makes ground water quality even more important.

Gravel mining also has the potential to threaten water quality as well as aquatic and riparian habitats within the watershed. The negative impacts of gravel mining have been shown to include channel deepening, sedimentation of downstream habitats, accelerated bank erosion, the formation of a wider and shallower channel, the lowering of the floodplain water table, and channel shift (Roell 1999). In 1998 there were 4 permitted operations within the Jacks Fork Watershed (Figure Wq01) (USACOE 1998).
Land disruption from road and bridge construction and maintenance as well as urban expansion often results in increased sediment loads to receiving water systems. Bridge construction also results in stream channel modification, which affects stream flow both up and downstream from the bridge. Since 1995 there have been no 404 permitted operations within the Jacks Fork Watershed (USACOE 1999).
According to the 2001-2005 Missouri Department of Transportation Highway and Bridge Construction Schedule http://www.modot.state.mo.us/local/d9/d9.htm,there are currently (2001) Two state highway construction projects scheduled within the watershed (MDT 2001). These involve bridge replacement of the Highway 17 Jacks Fork bridge and the Highway 19 Jacks Fork Bridge.

Non-point Source Pollution

Perhaps one of the more difficult challenges to address within any watershed is non-point source pollution. Whereas point source pollution can usually be traced to a single discharge point or area such as a waste water treatment plant discharge, non-point source pollution, such as sheet erosion of topsoil, runoff of nutrients from pastures, or pesticide or fertilizer runoff from a fields, is much more difficult to detect as well as remedy. It takes the cooperation of the landowners within a watershed to minimize non-point source pollution and its impacts.
The potential for contamination by septic systems has been shown by Aley (1972 and 1974) to be increased in areas of soluble bedrock. (MDNR 1984). As part of an Ozark National Scenic Riverways Groundwater Study, Aley and Aley (1987) identified pollution hazards including sewage disposal in the study region. They state that the primary type of sewage disposal within the study region is septic systems. Aley and Aley (1987) also state that according to a 1972 Missouri Clean Water Commission publication, sewage production is approximately 100 gallons per person per day. Using this information and assuming that nearly all of the populations of Mountain View and Eminence are served by municipal waste water treatment facilities, it can be estimated that 410,300 gallons of septic system effluent is generated per day within the Jacks Fork Watershed. Aley and Aley (1987) conclude that the "dispersed pattern of settlement in the study region is of great help in reducing groundwater contamination problems resulting from sewage disposal." Aley and Aley (1987) state that: "Instead, problems are centered on areas with concentrated settlement". It is important to stress that proper septic system installation and maintenance remains important to the protection of both surface and ground water systems.
Non-Point source contaminants of forestry activities within the Ozark National Scenic Riverways Groundwater Study Region were determined not to be significant enough to be designated by Aley and Aley (1987) as a hazard area within the study region. However, in certain areas of the study region, they did observe localized erosion "related primarily to logging roads and skid trails in rugged terrain" and concluded that "as a result, logging in the study region undoubtedly contributes to the sediment load of the springs in the Riverways". It is important to note that a considerable amount of land within the study region has since been transferred to public ownership.

As with other watersheds in the area, livestock, and in particular cattle populations, can potentially adversely affect both surface and ground water quality within the Jacks Fork Watershed. This is especially true when livestock are allowed to linger in riparian zones. Current estimates of livestock populations based on watersheds appear to be scarce if not non-existent. Much of the livestock population data currently available is based on county estimates. Applying this data proportionally to a watershed is a dubious method, at best, due to the potential variability of spatial distribution of livestock populations within counties. Land cover may provide a partial clue: Forests and woodlands makeup approximately 75% of the land cover within the Jacks Fork Watershed. Land cover within the riparian corridor reflects this characteristic. A high percentage of forest/woodland cover within the watershed would tend to indicate lower livestock populations. In addition, a high percentage of timbered riparian corridor would indicate, perhaps, more limited access to streams by livestock. Without good watershed-based livestock population data, much is left to speculation. What can be stated reliably is that limiting the presence of livestock from the riparian corridor is an effective way to help insure both surface and groundwater quality.

Other non-point pollution concerns within the Jacks Fork Watershed are recreation oriented. These include the large numbers of floaters (including people using johnboats, canoes, and innertubes) and people on summer weekends as well as horse trail rides and the associated facilities which are located along the Jacks Fork (MDNR 1994). As of 1994, monitoring had not shown any water quality problems associated with river recreation activities.

An increased awareness by the public will be important to the protection of both surface and ground water quality from non-point sources of pollution within the Jacks Fork Watershed.

Water Pollution and Fish Kill Investigations

As discussed previously, 5 miles of Jacks Fork River from (T29n, R3w, section 9 to T29n, R4w, section 26) are currently included in the 1998 303(d) list due to elevated fecal coliform levels (MDNR 1999d). Table Wq04 lists 7 water pollution impacts which have occurred within the Jacks Fork Watershed since 1990 (MDC 1991-1995; MDNR 1999e; and MDC 1999a). Elevated fecal coliform levels were the most frequent impact. No known fish kills have occurred within the watershed since 1990. The Missouri Department of Conservation has not performed toxicological sampling of fish from the Jacks Fork Watershed.

Water Use

Estimates of water use for the Jacks Fork Watershed are currently unavailable. However, water use data for the Current River Watershed (of which the Jacks Fork is a part) obtained from the United States Geological Survey National Water Use Database (1998b) indicate that total water withdrawn within the Current River Watershed in 1995 was 34.99 million gallons per day (mgd). Most of the water withdrawn in the watershed was from the groundwater system. Groundwater withdrawn within the watershed was 29.46 million gallons per day (mgd) while surface water withdrawn was 5.53 mgd.

Estimated water withdrawal for irrigation purposes was the most prevalent use within the Current River Watershed in 1995 (USGS 1998b). Combined groundwater and surface withdrawals for irrigation equaled 30.38 million gallons per day (mgd). It is important to note that irrigation is not a use of the two major water users (defined as those facilities capable of withdrawing 100,000 gallons/day) in the Jacks Fork Watershed; thus, the large amount of water withdrawn for irrigation in the Current River Watershed is not believed to be reflected in the

Jacks Fork Watershed (MDNR 1997). Domestic use was the second most prevalent within the Current River Watershed with domestic deliveries equaling 2.51 mgd.

Self-supplied water withdrawn in 1995 for domestic use equaled 1.08 mgd. The human population within the Jacks Fork Watershed comprises approximately 21% of the total estimated Current River Population. Since domestic water use is directly related to human population, it is estimated that domestic water use for the Jacks Fork is 21% of that of the Current River Watershed or 0.53 mgd.

Major water use information for the Jacks Fork Watershed was obtained from the Missouri Department of Natural Resources (MDNR), Division of Geology and Land Survey. The MDNR maintains records of "major" surface and ground water users (those facilities capable of withdrawing 100,000 gallons/day) throughout the state. Recent records (1997) indicate there were two major water users within the watershed. These were the Cities of Mountain View and Eminence which had ground water withdrawals of approximately 147 million gallons and 40 million gallons respectively in 1997 (MDNR 1997).

Recreational Use

In 1982, the recreational value of the Jacks Fork Watershed was ranked fifth out of 37 major watersheds in Missouri (MDC and MDNR 1982). Results were obtained by surveying professional staff from six state and federal agencies. Threats to the Jacks Fork which would result in a lower of its ranking were identified as intensive recreational use, bank and shoreline development, and poor land use with intensive recreational use being the primary factor in the decline.

The National Park Service initiated a river use management plan in 1985 in order to help insure that the Jacks Fork, as well as the Current River, would continue to provide quality and diverse recreational opportunities to the public. This plan was designed, in part to "protect the river environment and provide a variety of quality recreational experiences for visitors" (NPS 1989). This was accomplished by dividing the Jacks Fork and the Current River into zones and establishing maximum levels of canoe use designated as low (up to 10 canoes per mile), medium (11-40 canoes per mile), and high (41-70 canoes per mile). In some zones, the established maximum level of canoe use was different between weekends/holidays and weekdays.

The Jacks Fork River was divided into two zones: Zone 9-the confluence of the North and South Prongs to Alley Spring (24.5 miles) and Zone 10-Alley Spring to Two Rivers (14.9 miles). Both Zones were designated for medium canoe use during all time periods. in order to help insure that the Jacks Fork, as well as the Current River, would continue to provide quality and diverse recreational opportunities to the public. In order to evaluate the fulfillment of objectives set forth in the river use management plan, a monitoring program was established which set forth a periodic river use survey (Brown and Chilman 1998).

Since the establishment of a monitoring program, river use surveys were conducted in 1987, 1990, 1993, and 1997. In 1997, surveys were conducted between May 16 and August 13 (Brown and Chilman 1998). Canoes were the most prevalent watercraft, accounting for approximately 89% of total watercraft followed by innertubes (9%), johnboats (1%), and kayaks (<1%). Weekends accounted for the most use of the river by watercraft at 80% with an average daily count of 214 watercraft. Weekdays accounted for 20% of watercraft use with a daily average of 44 watercraft. It is important to note that counts were only performed on four of the five weekdays.

Angler surveys are useful for evaluating angler use, species preference, and satisfaction. Angler surveys can also be used to identify changes or trends in angler responses over time. These surveys provide the information necessary for managers to meet angler needs, as well as improve and validate decisions to change or maintain regulations.

Results from statewide annual angler surveys which were conducted by the Missouri Department of Conservation from 1983 to 1986 estimate that on an annual basis, an average of 45,979 total hours were spent angling on the Jacks Fork River and its tributaries (MDC 1987). Total hours fished increased from 53,920 in 1983 to 71,094 in 1984. Pressure dropped to 32,135 total hours in 1986. Bass species accounted for the most preferred group fished for. On average, 16,290 hours (35%) were spent fishing for bass per year. However, most angling pressure, an estimated average 20,529 hours per year (45%), was not directed at a specific species.

Angler surveys have been conducted annually on the Jacks Fork River since 1990 (1990, 1991, and 2000 data currently unavailable) in conjunction with a smallmouth bass research project being carried out by the Missouri Department of Conservation (MDC 1999b). These surveys are focusing on 37.4 miles in three segments (one treatment and two non-treatment segments) of the Jacks Fork River. Initially, these surveys were daytime surveys conducted throughout the year. However, due to low fishing pressure during the winter months, the survey period was shortened, beginning in 1992, to include only the period of April through October of each year. For the purposes of this document, data from the previously mentioned segments are combined. Average fishing pressure for the area and time period previously described was estimated to be 8,276 hours. Pressure ranged from a maximum of 15,702 hours in 1992 to 3,421 in 1997. Angling pressure in 1998 was 4,547. It is important to note that these are preliminary findings and thus may be subject to future modification. This survey is scheduled to be concluded in 2001 (Kruse, personal communication).

Figure Wq01.

Jacks Fork Watershed
Water Quality

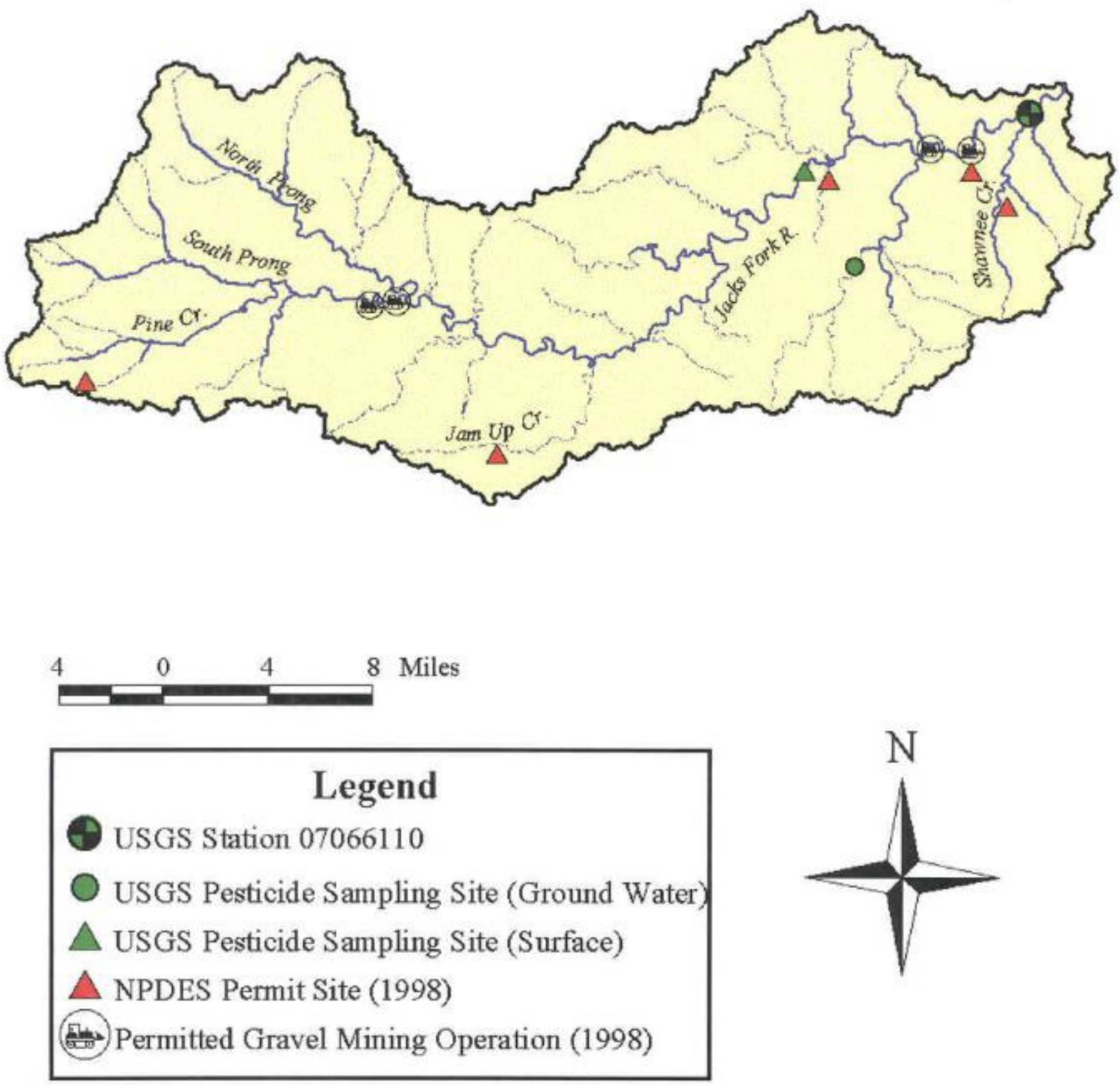
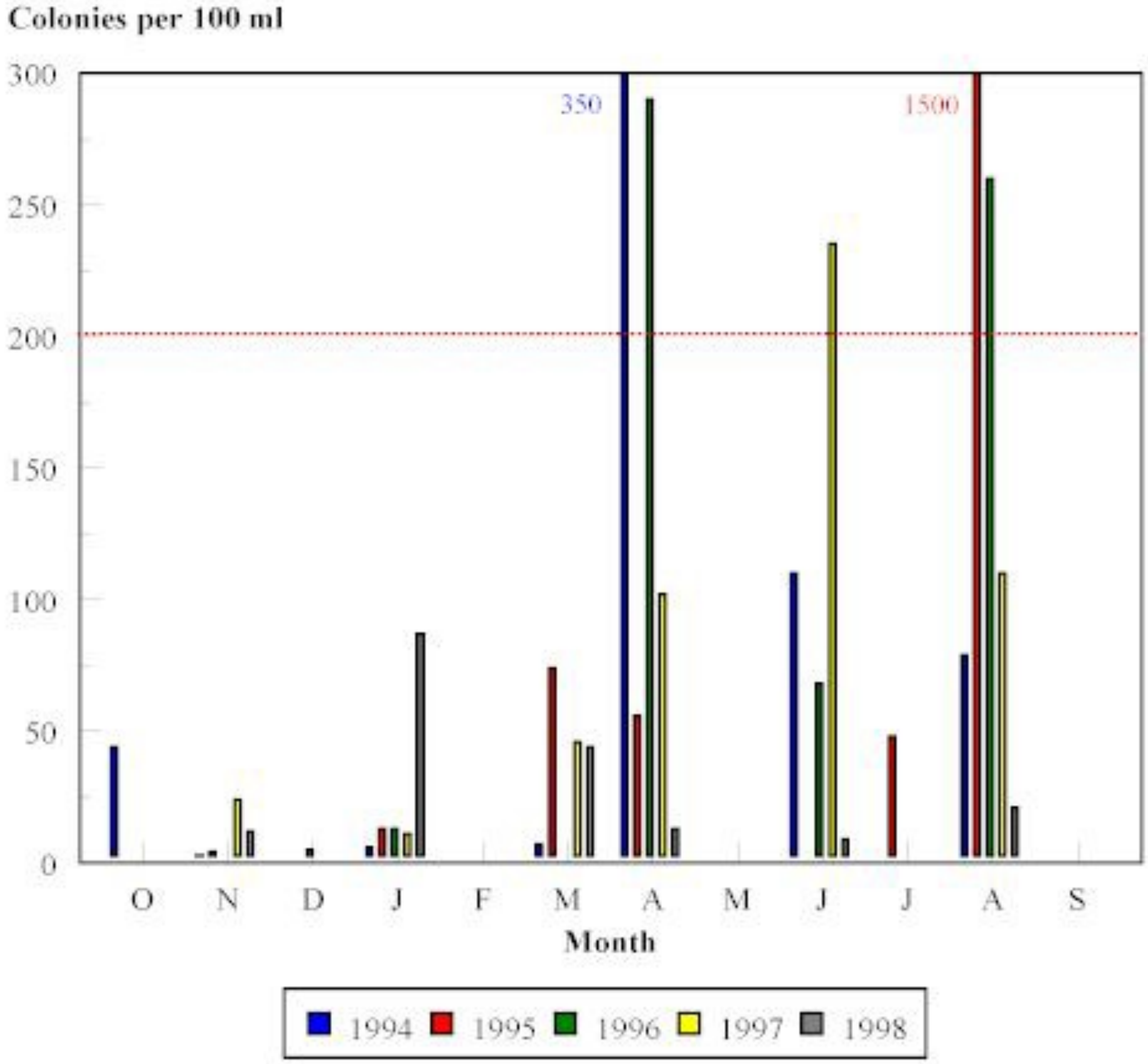


Figure Wq02. Fecal colliform colony counts per 100 milliliters at Station 07066110 (Jacks Fork above Two Rivers) (USGS 1995, 1996, 1997a, and 1998a, 1999a).



Dashed red line represents limit in waters designated for whole body contact recreation from April 1-October 31 and any time for losing streams (MDNR 1996a).

Note: Data includes results based on colony count outside the acceptable range (non-ideal colony count). A non-ideal colony count refers to counts in which crowding and insufficient media (insufficient for full development of colonies) exist for an ideal colony count or the colony count is so low that its statistical validity is questionable (USGS 1997b).

Table Wq01. Missouri Department of Natural Resources use designations for selected streams within the Jacks Fork Watershed (MDNR 1999a). Locations are given in section, township, range format.

Stream Name	Class[1]	Miles	From	To	Designated Use*
Alley Br.	P	1	Mouth	25,29n,5w	lww, aql
Alley Br.	C	2	25,29n,5w	22,29n,5w	lww, aql
Trib. to Alley Br.	C	1	Mouth	22,29n,5w	lww, aql
Barn Hol.	C	8	Mouth	18,27n,7w	lww, aql
Trib. to Barn Hol.	C	1	Mouth	4,27n,7w	lww, aql
Clear Spring	P	0.1	Mouth	19,28n,8w	lww, aql
Coon Hol.	C	3	Mouth	14,28n,7w	lww, aql
Flinger Br.	C	1.7	Mouth	17,28n,8w	lww, aql
Grassy Hol.	C	3.9	Mouth	9,28n,7w	lww, aql
Jacks Fork	P	39	Mouth	29,28n,7w	lww, aql, clf, wbc, btg
Jam Up Cr.	P	3	Mouth	16,27n,6w	lww, aql
Jam Up Cr.	C	2	16,27n,6w	20,27n,6w	lww, aql
L. Shawnee Cr.	P	2	Mouth	29,29n,3w	lww, aql
L. Shawnee Cr.	C	2	29,29n,3w	4,28n,3w	lww, aql
Mahan's Cr.	P	4	Mouth	9,28n,4w	lww, aql, clf
Mahan's Cr.	C	4.1	9,28n,4w	28,28n,4w	lww, aql
Mayhen Br.	C	1.3	Mouth	18,28n,8w	lww, aql
N. Prong Jacks Fk.	P	8	29,28n,7w	11,28n,8w	lww, aql
N. Prong Jacks Fk.	C	7	11,28n,8w	25,29n,9w	lww, aql
Open Hol.	C	1	Mouth	16,28n,4w	lww, aql
Panther Hol.	C	1.1	Mouth	10,27n,7w	lww, aql
Peters Cr.	C	3.5	Mouth	22,29n,8w	lww, aql
Pine Br.	C	4.2	Mouth	1,28n,8w	lww, aql
Pine Cr.	P	8	Mouth	5,27n,9w	lww, aql
Pine Cr.	C	1	5,27n,9w	5,27n,9w	lww, aql
Pine Hol.	C	4	Mouth	25,28n,5w	lww, aql
S. Prong Jacks Fk.	P	6	29,28n,7w	21,28n,8w	lww, aql
S. Prong Jacks Fk.	C	4	21,28n,8w	14,28n,9w	lww, aql
Shawnee Cr.	P	2	Mouth	30,29n,3w	lww, aql
Shawnee Cr.	C	10.3	30,29n,3w	19,28n,3w	lww, aql
Shuld Br.	C	2	Mouth	26,28n,9w	lww, aql
Stories Cr.	C	2.5	Mouth	16,29n,4w	lww, aql

Stream Name	Class[1]	Miles	From	To	Designated Use*
Wolf Cr.	C	5.2	Mouth	10,27n,8w	lww, aql
Wyrick Br.	C	1.3	Mouth	10,28n,9w	lww, aql

Note: This table is not presented as a final authority.
* lww-livestock & wildlife watering clf-cool water fishery
aql-protection of warm water aquatic life wbc-whole body contact recreation and human health-fish consumption. btg-boating & canoeing
[1]P-Streams that maintain permanent flow even in drought periods.
C-Streams that may cease flow in dry periods but maintain permanent pools which support aquatic life.

Table Wq02. Selected water quality data for gage station 07066110 (Jacks Fork above Two Rivers) for water years 1994-1998 (USGS 1995, USGS 1996, MDNR 1996a, USGS 1997a, USGS 1998a, USGS 1999a). This table is not a final authority.

Parameter	State Standard					Measurement
	I	III	V	VI	VII	
Temperature (°F) (cool water fishery)	84.0 Max					41.0-74.5
pH	6.5-9.0					6.9-8.5
Oxygen, dissolved (mg/L) (cool water fishery)	5.0 Min					7.7-13.2
Coliform, fecal (colonies / 100 ml)				200		k1-1500
Streptococci, fecal (colonies / 100 ml)						k2-800
Alkalinity1 (mg/L as CaCO3)						91-231
Hardness (mg/L as CaCO3)						140-180
Total Ammonia (mg/L as N)	0.1-32.12					<0.010-0.048
Phosphorus, Total3 (mg/L as P)						<0.02-0.120
Manganese, dissolved (ug/L as Mn)		50			50	1-7
Fluoride, dissolved (mg/L as F)		4	4		4	<0.10
Iron, dissolved (ug/L as Fe)	1000	300			300	<3-20

I - Protection of aquatic life
III - Drinking water supply
V - Livestock and Wildlife Watering
VI - Whole-body-contact recreation
VII - Groundwater
k Non-ideal count of colonies (too large a sample, colonies merged)
[1]State standard for alkalinity currently unavailable. The Environmental Protection Agency currently recommends a minimum of 20.0 mg/L (USEPA 1999).
[2]Based on maximum chronic and acute standards for cold-water fishery. Levels are pH and temperature dependent. The maximum acute value at 4o C and pH of 6.6 is 32.1 mg/l. The maximum acute value at 30o C and pH of 9.0 is 0.6 mg/l. The maximum chronic value at 4o C and pH of 6.6 i2.4 mg/l. The maximum chronic value at 30o C and pH of 9.0 is 0.1 mg/l. For specific criteria at varying pH and temperatures consult Table B of the Rules of the Department of Natural Resources Division 20-Clean Water Commission Chapter 7- Water Quality. s
[3]State standard for phosphorus is currently unavailable. The Environmental Protection Agency currently recommends a maximum of 0.1mg/L for rivers (Christensen and Pope 1997).

Table Wq03. National Pollution Discharge Elimination (NPDES) permit sites within the Jacks Fork Watershed (MDNR 1998a).

Facility Name	Receiving Stream	Facility	County
Mountain View WWTP	Jam Up Cr.	Waste Water Treatment Plant	Howell
Willow Springs Landfill	Trib. Pine Cr.	Land Fill	Howell
U.S. National Park Service	Jacks Fork R.	Park*	Shannon
Bryan Pump and Plumbing	L. Shawnee Cr./ Jacks Fork	Sludge Disposal/ Hauler	Shannon
Eminence WWTF	Jacks Fork R.	Waste Water Treatment Plant	Shannon

Note: This table is not a final authority. Data subject to change.
*Waste water treatment plant (land application of effluent)

Table Wq04. Fish kill and water pollution impacts investigated within the Jacks Fork Watershed from 1990-1998 (MDC 1991-1995; MDC 1999a; and MDNR 1999e).

Date	Stream	Facility Ownership	Fish Kill	Impact Description
11/90	Jacks Fork	N/A	No	Transportation: truck
6/11/92	Jacks Fork, North & South Prongs	N/A	No	Other Source: Erosion sediment/nutrient runoff.
8/14/92	Jacks Fork	Private	No	Agricultural: Horse manure/bedding.
10/92, 8/93, 10/93	Jacks Fork	Private	No	Elevated fecal coliform
6/93	Jacks Fork	Municipal	No	High effluent.
6/25/94	Mahans's Creek	N/A	No	Transportation: Asphalt oil.
2/26/96	Jacks Fork	?	No	?

N/A = Not Applicable
? = No data given

Habitat Conditions

Dam and Hydropower Influences

Within the Jacks Fork Watershed there are currently two dams which have records within the Dam and Reservoir Safety Program Database (Figure Hc01) (MDNR 2000d). One is a reinforced earth structure located on a tributary of the South Prong of the Jacks Fork River. The height of this dam is 27 feet. The other dam is a reinforced earth structure with a height of 41 feet located on a tributary of Shawnee Creek.

Section 236.400 of the Missouri Revised Statutes defines a dam as "any artificial or manmade barrier which does or may impound water, and which impoundment has or may have a surface area of fifteen or more acres of water at the water storage elevation, or which is thirty-five feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier or dam, if it is not across a streambed or watercourse, together with appurtenant works" (MGA 2000a).

The Dam Safety Law of 1979 established a "Dam and Reservoir Safety Council" associated with the Missouri Department of Natural Resources (MDNR 2000b and MGA 2000a). The responsibility of this council is to "carry out a state program of inspection of dams and reservoirs in accordance with regulations of the council (MDNR 2000c). The Missouri Department of Natural Resources Dam and Reservoir Safety Program operates under the guidance of the council. The program is responsible for regulating all new and existing non-federal, non-agricultural dams which have a height of 35 feet or greater in order to ensure that these structures meet minimum safety standards. In order to facilitate this, the program maintains a database on over 4,000 dams within the state to be used by private owners, professional engineers, mining companies, emergency management officials, educational institutions, other government agencies as well as private individuals (MDNR 2000c). This database includes permitted dams as well as some dams which don't require a permit.

In an effort to further determine the presence of significant dam and reservoir structures within the watershed, analysis was performed on National Wetlands Inventory (NWI) http://www.nwi.fws.gov/overiew.htm GIS data for the watershed. Data was analyzed based on all diked/impounded waters within 100 feet of third order (Strahler) and larger stream segments. This method yielded 8 potentially significant diked/impounded sites. The largest of these sites was 2.79 acres; with the smallest being .05 acres (Table Hc01).

Channel Alterations

There have been no significant channel alterations anywhere throughout the Jacks Fork Watershed. Small channelization projects have probably occurred on private property and also from road and bridge construction. However, these activities currently are not considered to be a major threat to the river system. According to the 2001-2005 Missouri Department of Transportation Highway and Bridge Construction Schedule, http://www.modot.state.mo.us/local/d9/d9.htm, there are currently (2001) Two state highway construction projects scheduled within the watershed (MDT 2001). These involve bridge replacement of the Highway 17 Jacks Fork bridge and the Highway 19 Jacks Fork Bridge.

The negative impacts of gravel mining have been shown to include channel deepening, sedimentation of downstream habitats, accelerated bank erosion, the formation of a wider and shallower channel, the lowering of the floodplain water table, and channel shift (Roell 1999). In

1998 there were 4 permitted operations within the Jacks Fork Watershed (Figure Wq01) (USACOE 1998).

Natural Features

The Missouri Department of Conservation inventoried counties within the Jacks Fork Watershed between 1986 and 1991 for unique natural features (Nigh 1988; Ryan and Smith 1991). The inventories recognized seven categories of natural features: examples of undisturbed natural communities, habitat of rare or endangered species, habitat of relict species, outstanding geological formations, areas for nature studies, other unique features, and special aquatic areas having good water quality, flora, and fauna.

Since the initial natural features inventory effort, the Missouri Natural Heritage Database (NHD) has been created. The database lists many of the features which were included in the Missouri Natural Features Inventory. The database, which is updated frequently, is a dynamic representation of the occurrence of many natural features in Missouri. Currently the database contains 256 features for the Jacks Fork Watershed. These include 61 examples of 12 types of natural communities: The Jacks Fork River is recognized as a significant example of an Ozark creek and small river community (MDC 1999c). Caves and dolomite glades are common throughout the watershed with many dolomite glades being rated as exceptional. Recorded occurrences of natural features currently (1999) in the NHD for the Jacks Fork Watershed include;

- Caves-23
- Chert Savanna-4
- Creeks and Small Rivers (Ozark)-1
- Deep Muck Fen-2
- Dolomite Glade-16
- Dry Limestone/Dolomite Cliff-2
- Dry-Mesic Chert Forest-2
- Fen-5
- Gravel Wash-1
- Moist Limestone/Dolomite Cliff-1
- Oxbows & Sloughs (Ozark)-1
- Pond Marsh-1

A detailed description of these terrestrial natural communities can be found in *The Terrestrial Natural Communities of Missouri* by Nelson (1987), while a detailed description of Missouri's aquatic communities can be found in Aquatic Community Classification System for Missouri by Pflieger (1989).

Undoubtably more examples of natural features exist within the watershed. However due to many circumstances including the limited access to private land and the large land area, many features may be as yet unrecorded. Therefore, the previous listing of features should not be regarded as final or comprehensive. However, this listing does provide a good cross section of the types of communities which can be found within the watershed.

Improvement Projects

There are 3 stream improvement projects within the Jacks Fork Watershed. These include a two cedar tree revetment projects and a rock barb project. Table Hc02 lists stream improvement projects in the watershed.

Stream Habitat Assessment

Perhaps one of the more difficult attributes of a watershed to attempt to quantify is stream habitat. This is due to the fact that there are several dynamic characteristics which make up stream habitat. To evaluate all of these characteristics individually and accurately for an entire watershed is a monumental task and beyond the scope of this document. Thus, the next best thing is to evaluate a characteristic that has the most impact on all aspects of stream habitat. This is, arguably, riparian corridor land cover/land use.

Riparian corridor land cover effects many aspects of stream habitat. These include, but are not limited to water temperature, turbidity, nutrient loading, sand/gravel deposition, in-stream cover, flow, channel width, and channel stability. These in turn have effects on still other characteristics of stream habitat such as dissolved oxygen, cover, spawning areas, etc.

Evaluation of riparian corridor land cover/land use within the Jacks Fork Watershed was accomplished using Missouri Resource Assessment Partnership Phase 1 Land Cover Data (morapmd.wpd). A buffer zone 3 pixels (90 meters) wide was created which corresponded to a 1:24,000 hydrography coverage for the watershed. This was split into segments no longer than 0.25 miles long (Caldwell, personal communication). Percent land use for each segment was then calculated. Land cover/land use categories included forest, woodland, grassland, cropland, urban, and water. Percentages of these categories were then calculated for riparian corridors within each drainage units as well as for the whole watershed.

Results for the entire watershed indicate that riparian corridor land use consists of more forest/woodland (77.8%) than grassland/cropland (20.0%). Percentages for the remaining categories of urban and water are 0.9% and 1.4% respectively. Of the 12 drainage units within the watershed, the Lower South Prong Unit has the highest combined percentage of forest/woodland corridor land cover/land use at 91.2%. It also has the lowest combined percentage of grassland/cropland corridor land use at 7.3%. Table Hc03 gives riparian corridor land cover/land use percentages for all drainage units within the watershed as well as percentages for the total watershed. Figure Hc02 presents a graphic representation of riparian corridor land cover/land use for all drainage units within the watershed.

In addition to analysis of riparian corridor within drainage units, riparian corridor land cover/land use was analyzed for all fourth order (Horton) and larger streams within the watershed in order to determine those specific streams having a substantial amount of unforested riparian corridor. Analysis was based on stream miles as well as percentage of total stream miles with combined grassland, cropland, and urban land cover categories equaling greater than 25% of total riparian land cover/land use (referred to as non-forested for the purposes of this document) (Table Hc04 and Figure Hc02). Results indicate that the South Prong of the Jacks Fork has the highest percentage of stream miles with non-forested riparian corridor at 68.7% (11.2 miles) Pine Branch has the lowest percentage of non-forested riparian corridor at 0.2% (0.01 miles). Approximately 29.4% (14.5 miles) of the Jacks Fork River riparian corridor is non forested.

An aerial stream survey of the Jacks Fork Watershed was made during March and April, 1996. The survey flight included portions of the Jacks Fork, South Prong, North Prong, Peters Creek, and Pine Creek and many other major tributaries. A catalog of the flight, highlighting unstable stream and riparian areas and other significant landmarks was completed. Topographic maps were labeled according to the video index time. Information from this survey will be useful for a variety of projects such as future habitat assessment, assisting landowners with problems associated with stream bank erosion and deposition, reviewing gravel mining permits, selection of aquatic biota sampling sites, etc.

Sand and Gravel Mining Restrictions

Currently the entire Jacks Fork River is closed to sand and gravel mining from March 15 to June 15 (MDC 2000). The criteria for closing is based on the "Outstanding National Resource Waters" designation of the river and the "significant biological resources that may be impacted by sand and gravel excavation during periods of spawning, incubation, or rearing" (MDC 1997b).

Figure Hc01. **Jacks Fork Watershed**
Impoundment Influence and Spawning Restrictions

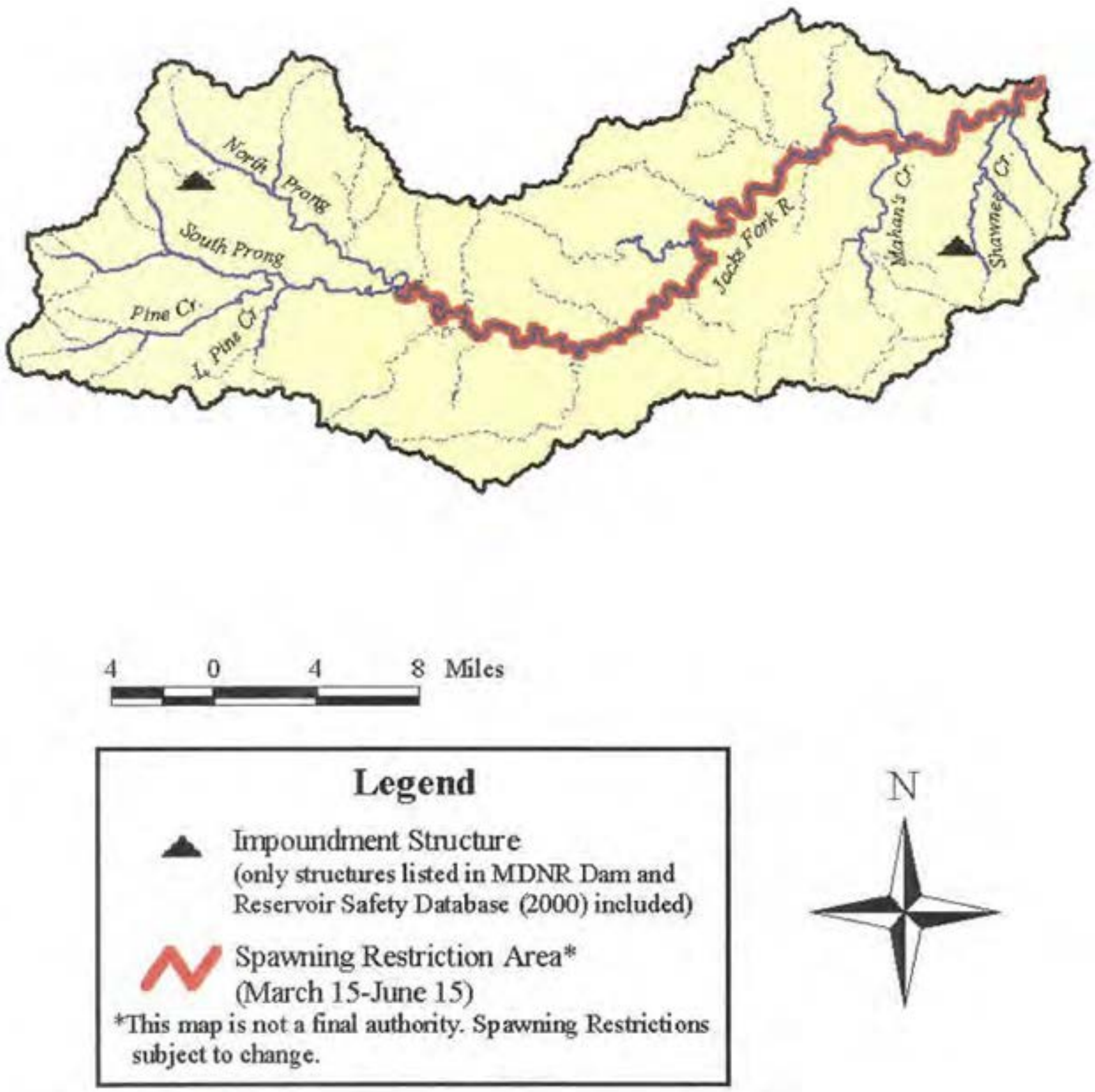


Figure He02. **Jacks Fork Watershed**

Riparian Corridor Land Cover

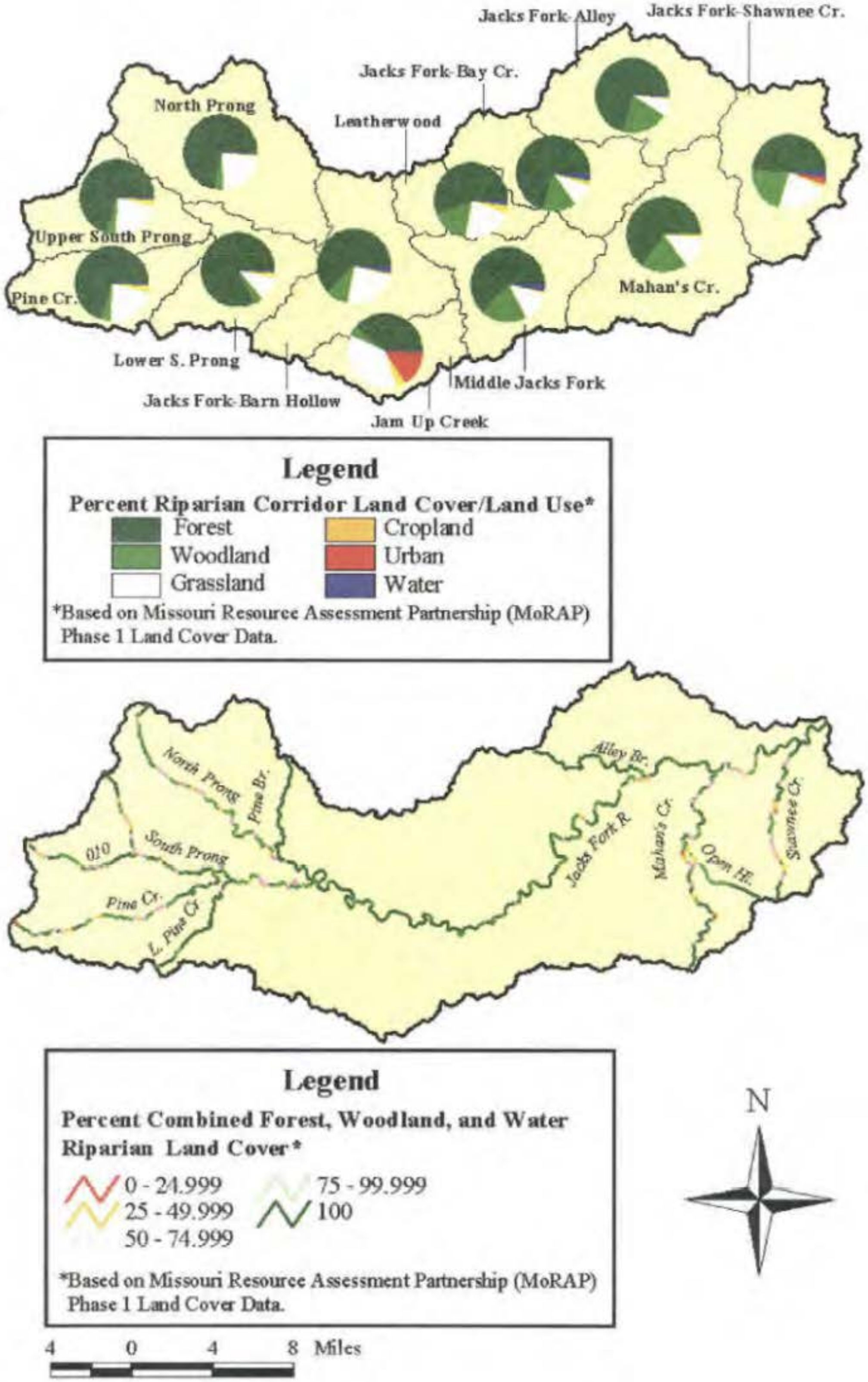


Table Hc01. Diked/Impounded Wetland within 100 feet of third order or larger (strahler) stream segment within the Jacks Fork Watershed based on National Wetlands Inventory (NWI) Data.

Stream	Size	Instream
Pine Creek	0.13	No
Pine Creek	0.12	No
Tributary of Little Pine Creek	0.09	No
Tributary of Little Pine Creek	0.15	Yes
North Prong Jacks Fork	2.79	Yes
Tributary of the Jacks Fork	0.22	Yes
Dry Camp Hollow	0.05	Yes
Shawnee Creek	0.17	Yes

Table Hc02. Stream improvement projects within the Jacks Fork River Watershed.

Affected Stream	Project Type	Original Installation Year
S. Prong Jacks Fork	Cedar Tree Revetment	1991
Jacks Fork	Rock Barb & Willow Plantings	1992
Jacks Fork near Alley Spring Branch	Cedar Tree Revetment & Willow Plantings	1995

Table Hc03. Percent riparian corridor land cover for drainage units within the Jacks Fork Watershed. Data is based on MoRAP Phase 1 Land Cover (1997).

Unit	FOR	WDL	GRS	CRP	URB	WAT
Pine Creek	69.9	3.8	22.2	3.1	0	0.9
Lower South Prong	81.5	4.3	11.3	2.1	0	0.8
Upper South Prong	70.3	3.6	22.2	3.2	0	0.8
North Prong	72.1	4.1	21.8	1.4	0	0.5
Jacks Fork-Barn Hollow	62.3	10.2	23.5	1.4	0	2.6
Middle Jacks Fork	61.4	19.4	12.4	0.9	0	2.7
Jam Up Creek	38.8	4.5	37.0	4.3	15.3	0.2
Jacks Fork-Bay Creek	70.5	15.4	9.9	1.7	0	2.6
Leatherwood	55.9	16.3	21.8	3.9	0	2.2
Mahan's Creek	65.1	19.9	13.8	0.9	0	0.3
Jacks Fork-Alley Branch	71.4	19.8	6.5	0.8	0	1.4
Jacks Fork-Shawnee Creek	49.5	20.6	23.1	2.2	3.0	1.7
Watershed	65.5	12.3	18.1	1.9	0.9	1.4

FOR =Forest, WDL=Woodland, GRS=Grassland, CRP=Cropland, URB=Urban, WAT=Water

Table Hc04. Stream miles as well as percentage of total stream miles (in parenthesis) for fourth order (Horton) and larger streams with combined grassland, cropland, and urban (non-forested for the purposes of this document) land cover categories equaling 25% or greater of total riparian land cover/land 000 use. Results given by order (Strahler) as well as total stream length. Data is based on 1:24, hydrography layer combined with Missouri Resource Assessment Partnership (MoRAP) Phase 1 Land Use/Land Cover Data (1997).

Stream	Order						Total
	1st	2nd	3rd	4th	5th	6th	
Alley Br.	0	0	0.47 (31.1)	0.70 (26.1)			1.17 (16.8)
Jacks Fork					14.5 (29.4)		14.5 (29.4)
JFW010	0.23 (38.3)	1.12 (73.7)	1.32 (100)	1.52 (46.9)			4.19 (62.7)
L. Pine Cr.	0.49 (41.9)	-	0.47 (23.2)	0.05 (1.4)			1.01 (14.8)
Mahan's Cr.	0	0	0.56 (57.7)	3.33 (66.2)	4.02 (71.0)		7.91 (60.4)
N. Prong	0.17 (19.8)	1.31 (78.0)	2.38 (78.3)	6.88 (89.6)	0.46 (11.5)		11.2 (64.9)
Open Hl.	0	0	2.77 (96.2)	0.7 (86.4)			3.47 (66.6)
Pine Cr.	0	0	1.84 (74.5)	6.48 (68.0)			8.32 (64.2)
Pine Br.	0.01 (1.4)	0	0	0			0.01 (0.2)
Shawnee Cr.	0	0.26 (35.1)	4.41 (80.5)	1.36 (43.0)			6.03 (61.2)
S. Prong	0	0.32 (32.7)	1.73 (95.6)	0.95 (95.0)	8.16 (70.6)		11.16(68.7)

Biotic Communities

Stream Fish Distribution and Abundance

Historical records of fish collections within the Jacks Fork Watershed date back to 26 June, 1941 (MoRAP 2000). Fish collection sites are presented in Figure Bc01. From 1941 to 1997, 67 fish species (not including hybrids or larval lamprey) in 16 families have been collected within the watershed (Table Bc01) (MDC Ozark Regional Fish Collection Files; Pflieger 1989; Pflieger 1997; MDC 1999c; MoRAP 2000a).

Table Bc02 shows fish species distribution by modified 14 digit hydrologic unit. While this information provides insight into areas of the watershed where species have been collected in the past, it is important to note that the number of fish sampling sites as well as collections vary greatly between drainage units (no data is available for some units), thus negating the use of this data for any quantitative analysis.

Prior to 1981, a total of 66 fish species (not including hybrids) in 15 families were collected (including observations) within the watershed (MDC Ozark Regional Fish Collection Files; Pflieger 1989; Pflieger 1997; MDC 1999c; MoRAP 2000a). From 1981 to 1997, a total of 50 species in 16 families have been collected.

Seventeen species of fish which were observed prior to 1981 were not observed after 1980. Nearly all of these were only observed in one or two collections previously with many having not been collected prior to 1961. In addition, not all sites which had harbored these species previously were sampled after 1980 (Table Bc03). The most notable exceptions to this are the gilt darter and the American brook lamprey.

Both species were collected at two separate sites from 1941-1960 and 1961-1980. These sites were again sampled after 1980 with no observations of these species. While the gilt darter appears to have never been widespread within the Jacks Fork Watershed, it has been collected at several sites within the rest of the Current River Basin (Pflieger 1997). The American brook lamprey is not common within the Missouri Ozarks. Pflieger (1997) states that "most distribution records are based on specimens collected more than 20 years ago". Despite both species having been collected at a minimal number of sites within the watershed, their absence in post 1980 collections emphasizes the need for additional attempts to detect their presence with particular emphasis given to those historical sites where these species were previously collected.

The southern cavefish is the only species collected within the Jacks Fork Watershed since 1981 which had not been collected in the watershed previously. This species was collected at a single site in 1992.

The fish fauna of the Jacks Fork Watershed is dominated by species which are characteristic species of the Ozark faunal region based on the faunal region classification of species as developed by Pflieger (1989) (Table Bc01). Thirty seven (56%) species are characteristic Ozark species, 6 (9%) are Ozark-Prairie, 6 (9%) Ozark-lowland, 3 (4%) Ozark-Big River, 1 (1%) Ozark-Prairie-Lowland, (1)1% Prairie, 2 (3%) Big River, 1 (1%) Lowland, and 8 (12%) widely distributed. In addition to these species 2 species (2%) are introduced or non-native species. These are the carp and goldfish.

Sport Fish

The tributaries of the Jacks Fork Watershed offer a variety of angling opportunities. A total of 5 species of sport fish (as defined as game fish in MDC 1999d) are known to occur within the watershed (MDC

Ozark Regional Fish Collection Files; Pflieger 1997; MDC 1999c; MoRAP 2000a). These include chain pickerel, shadow bass, smallmouth bass, largemouth bass, and warmouth. Other game fish species including walleye, spotted bass, and paddlefish have been observed in the watershed in the past.

However, these are not considered to be significant fisheries if these species are even currently present at all. The last collections of these species occurred prior to 1981.

The Jacks Fork River from Highway 17 to Highway 106 is currently (2000) managed under smallmouth bass special management regulations as part of a smallmouth bass research project currently being conducted by the Missouri Department of Conservation (MDC 1999b). This includes an 18 inch minimum length limit on smallmouth bass and a daily limit of 6 black bass which may include only 1 smallmouth bass (please refer to current copy of the Missouri Wildlife Code for the most updated regulations). As stated previously, this is part of a study implemented to "evaluate and recommend strategies for managing high-quality smallmouth bass fisheries in streams" (MDC 1999b). The remainder of streams within the Jacks Fork Watershed are currently (2000) under statewide regulations. As part of the aforementioned study, an angler survey has been ongoing since 1990 on the Jacks Fork River in order to determine the effect of the special smallmouth regulation on angling success for smallmouth bass and shadow bass, angler acceptance of the regulation, and economic value of the fishery (MDC 1999b). The survey has been split between two different time periods designated as Segment I (pre-regulation 1990-1994) and Segment II (post-regulation 1995-1998) and includes both the smallmouth bass special management area (treatment area 24.3 miles) as well as 13.1 miles of the Jacks Fork under statewide regulations (non-treatment area). Initially, these surveys were daytime surveys conducted throughout the year. However, due to low fishing pressure during the winter months, the survey period was shortened, beginning in 1992, to include only the period of April through October of each year. This survey was originally scheduled to conclude in 2000 but has been extended through 2001 (Kruse, personal communication).

Preliminary analysis of the creel data shows an overall decline in catch of both smallmouth and shadow bass as well as angler use between the pre-regulation and post-regulation periods for both the treatment and non-treatment areas (Table Bc04). Combined catch of smallmouth and shadow bass in the treatment area averaged 12,749 and 2,334 in the pre-regulation and post-regulation periods respectively. Combined catch of smallmouth and shadow bass in the non-treatment area averaged 1,747 and 1,028 in the pre-regulation and post-regulation periods respectively. Not surprisingly, estimated catch of both smallmouth and shadow bass appear to correspond to trends in angler use (Table Bc04). Angler use in the treatment area averaged 4,394 trips (9840 hours) and 976 trips (2722 hours) in the pre-regulation and post-regulation periods respectively. Angler use in the non-treatment area averaged 2,653 trips (3032 hours) and 1,142 trips (2107 hours) in the pre-regulation and post-regulation periods respectively. As stated previously, this project is currently ongoing and thus results are preliminary. Additional data collection and analysis are yet to be done.

Fish Stocking

Currently there are no state or federal stream stocking efforts occurring within the Jacks Fork Watershed. It appears that little comprehensive data is available regarding historical fish stocking within the watershed. Ozark Regional Office stocking records indicate that no fish stocking in streams has occurred at least since 1985. The presence of the goldfish and common carp, both introduced species, within fish community collections from the watershed prior to 1981 would

indicate that these species had been stocked by some entity. The presence of goldfish could have been the result of a release from home aquaria, private pond, etc. In regard to common carp, Pflieger (1997) notes that in the late 1800s, "the Missouri Fish Commission reared more than 80,000 for stocking in public and private waters throughout the state. It is important to note that neither goldfish nor common carp have been detected within fish community samples in the watershed since 1980. It is assumed that if any historical stocking efforts had occurred which had significant impacts on the fish community of the watershed, other than those already mentioned, this impact would have been detected within the fish community collections. Undoubtedly farm ponds within the watershed have been stocked with largemouth bass, bluegill, and channel catfish by private individuals who obtained fish from the MDC, commercial dealers, and/or other water bodies. It can be assumed that many pond owners have also probably stocked grass carp. The potential of these fish being washed into streams exists in all major precipitation events. A lack of historical records, plus the occurrence of undocumented introductions makes it difficult to determine, with any reliability, all species which may have been introduced into the watershed. Effects of introductions vary. While the introduction of species already present in the watershed may have minimal to no effect, the introduction of non-native species can often times have disastrous consequences

Mussels

A total of 19 species of mussels are known to occur within the Jacks Fork Watershed (Table Bc05)(MoRAP 2000b). Of these, 3 species are former Federal category-2 candidates (see table for more information) (MDC 1999e). These are the elktoe *(Alsmidonta marginata),* Ouachita kidneyshell *(Ptychobranchus occidentalis*), and purple lilliput *(Toxolasma lividus).* Figure Bc02 displays mussel sampling sites within the watershed. Mussel species included currently listed as "Species of Conservation Concern" include the Arkansas brokenray *(Lampsilis reeveiana reeveiana)* in addition to the three previously mentioned species.

Snails

Two species of snails have been identified within the Jacks Fork Watershed (Wu. 1997). These are the pyramid elimia *(Elimia potosiensis)* and Goodrich's physa *(Physa goodrichi).*

Crayfish

Five species of crayfish are known to occur within the Jacks Fork Watershed. These include the Ozark crayfish *(Orconectes ozarkae),* golden crayfish *(Orconectes luteus),* spothanded crayfish *(Orconectes punctimanus),* Hubbs' crayfish *(Cambarus hubbsi),* and the Salem cave crayfish *(Cambarus hubrichti)* (Pflieger 1996, MDC 1999c, and MoRAP 2000c). Four species have distributions in or closely associated with the Ozark Region (Pflieger 1996). The Ozark crayfish is found only in the White and Black River Basins in Missouri and Arkansas. The spothanded crayfish is found in the eastern half of the Ozarks in Missouri and adjacent counties in Arkansas. This species is also found in Callaway, Montgomery, and Warren Counties north of the Missouri River. The Hubbs' crayfish is limited to the principal south flowing drainages in the Ozarks from the James River Watershed in the West to the St. Francis Watershed in the East. The exception to this is the North Fork Watershed in which the Hubbs' crayfish is not found. The Salem cave crayfish, currently listed as a Missouri "Species of Conservation Concern", has been found only in Missouri and is believed to occur throughout the Eastern Ozarks from Camden to Crawford Counties, southward to Howell, Oregon, and Ripley Counties (Pflieger 1996). As its name

suggests, it is a subterranean species which has been observed in a variety of subterranean habitats such as cave streams over various substrates, subterranean lakes, as well as the outlets of large springs near the limit of daylight (Pflieger 1996). It has also, on occasion, been observed in more terrestrial areas such as the outflow of a small spring, the pool at the bottom of a deep sinkhole, and the ruts left by a truck in a fen. Figure Bc03 displays crayfish collection sites within the Jacks Fork Watershed.

Since 1991, a long-term research project focusing on crayfish has been ongoing on the Jacks Fork River (DiStefano 2000). The purpose of the project is to "develop management strategies for producing optimum numbers and sizes of crayfish to support optimum production of selected sport fishes in Missouri Ozark streams". This study has been integrated with the aforementioned smallmouth bass study in order to gain further understanding of the predator/prey relationship of smallmouth bass and crayfish. The study consists of four parts or "jobs": Job 1-literature and data review, Job 2-evaluation of sampling methods, job 3-determination of crayfish population characteristics, job 4-determination of the effects of Fishing/Harvest Regulations. Final reports for Jobs 1 and 2 have been completed. The Job 3 report is tentatively scheduled to be written in spring 2001, while the completion of the Job 4 report is to be written at a later time. Information regarding the availability of these final reports may be obtained by contacting the Missouri Department of Conservation, Fish and Wildlife Research Center, 1110 South College Avenue, Columbia, Missouri 65201.

Benthic Invertebrates

Two hundred taxa of aquatic invertebrates have been collected within the Jacks Fork Watershed since 1961 (MDC 1998d) (Table Bc06). From 1961-1974, 112 taxa were collected within the watershed. Since 1974, 165 taxa of aquatic invertebrates have been collected. Figure Bc04 displays benthic invertebrate collection sites within the Jacks Fork Watershed.

Species of Conservation Concern

Within the Jacks Fork Watershed, 51 species of conservation concern have been identified (Table Bc07) (MDC Ozark Regional Fish Collection Files, Pflieger 1996, MDC 1998c, MDC 1999c, MDC1999d, MoRAP 2000a, MoRAP 2000b). These include 32 species of plants (flowering plants, ferns, fern allies, and mosses); 2 species of insects; 1 species of crayfish; 4 species of mussels; 5 species of fish; 2 species of amphibian, 3 species of birds; and 2 species of mammals. One species, the gray bat, has both federal and state endangered species status. In addition, the Bachman’s sparrow is a state endangered species as well as a former federal candidate for listing.

The following is a brief description of aquatic oriented animal species of conservation concern within the Jacks Fork Watershed:

Fish

American Brook Lamprey

According to the best available data, the American Brook Lamprey has only been collected twice within the Jacks Fork Watershed (MDC Ozark Regional Fish Collection Files, MoRAP 2000a). The first collection occurred in 1941 in a single reach. The second collection occurred in 1966 in a separate reach.

Ozark Shiner
Since 1941 the Ozark Shiner has been collected in seven reaches within the Jacks Fork Watershed (MDC Ozark Regional Fish Collection Files, MoRAP 2000a). The latest collection of the Ozark Shiner was in 1997 at which time the species was collected in two reaches. The Ozark Shiner appears to be well distributed within the watershed; having been collected in 5 of the 9 drainage units since 1941 and also 5 of the 9 units since 1981.

Checkered Madtom
The best available data indicates that the first collection of the checkered madtom within the Jacks Fork Watershed occurred in 1966 at a single site (MDC Ozark Regional Fish Collection Files, MoRAP 2000a). The same site yielded this species again in 1994. In 1997, the checkered madtom was collected at three additional sites.

Paddlefish
According to the best available data, the only collection of paddlefish within the Jacks Fork Watershed was from a single site in 1966 (MDC Ozark Regional Fish Collection Files, MoRAP 2000a).

Southern Cavefish
According to the best available data, the Southern cavefish has only been collected from a single site within the Jacks Fork Watershed. This occurred in 1992. Because the southern cavefish does not generally occur in habitats which are typically represented in fish community collections, additional efforts may be required in order to further document this species distribution within the Jacks Fork Watershed.

Amphibians

Four-Toed Salamander
According to Johnson (1992), the four-toed salamander "is found in mosses along heavily forested, spring-fed creeks associated with igneous (Precambrian) rock, and also in and near natural sinkhole ponds". The Natural heritage database (MDC 1999c) indicates the last observation of the four-toed salamander within the Jacks Fork Watershed occurred in 1980. Ozark Hellbender -The Ozark Hellbender is restricted to the North Fork Watershed and to rivers and streams of the Black River System (Johnson 1992). According to the Natural Heritage Database, the last recorded observation of the Ozark Hellbender in the watershed was 1992 (MDC 1999c).

Mussels

Elktoe
The elktoe has been collected at two sites within the Jacks Fork Watershed. It was last collected in the watershed in 1973 (MoRAP 2000b).

Arkansas brokenray
The Arkansas Brokenray has been collected at 9 sites within the Jacks Fork Watershed (MoRAP 2000b). This species is relatively widespread within the watershed; being found in 6 of the 9 drainage units. It was last collected in the watershed in 1982.

Ouachita kidneyshell

The Ouachita kidneyshell has been collected at 9 sites within the Jacks Fork Watershed (MoRAP 2000b). This species is relatively widespread within the watershed; having been collected in 5 of the 9 drainage units. This species was last collected in the watershed in 1982.

Purple lilliput

The purple lilliput has only been collected at a single site within the Jacks Fork Watershed. This collection occurred in 1973 (MoRAP 2000b).

Crayfish

Salem Cave Crayfish

Pflieger (1996) indicates that the Salem Cave Crayfish has been collected at a single site within the Jacks Fork Watershed (no date given). As is the case with the southern cavefish, the Salem Cave Crayfish generally does not inhabit areas typically included in crayfish or benthic invertebrate samples. Additional sampling focused on subterranean habitats may be necessary in order to further document the distribution of this species within the watershed.

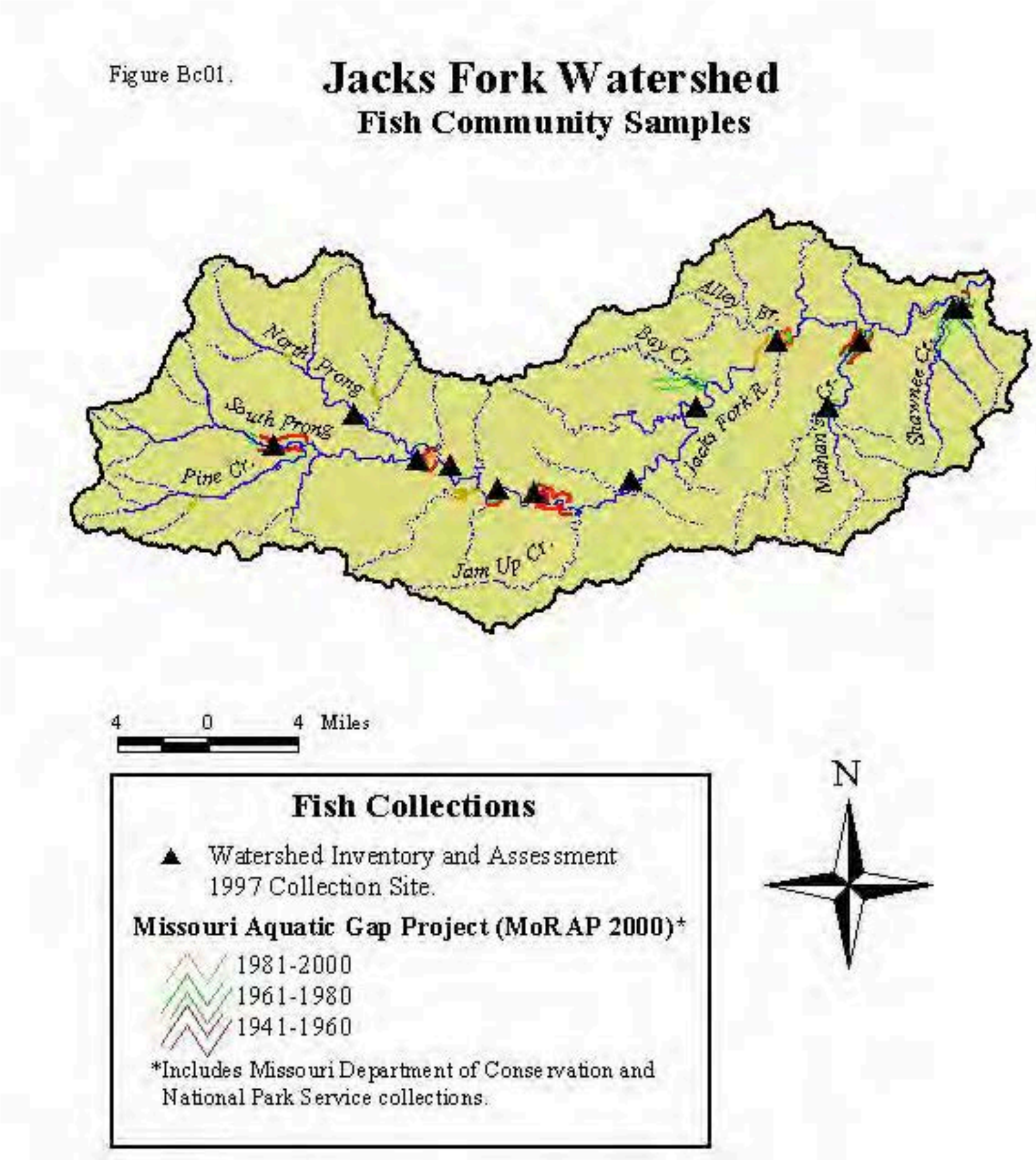


Figure Bc01.
Jacks Fork Watershed
Fish Community Samples
North Prong
South Prong
Pine Cr.
Jam Up Cr.
Bay Cr.
Alley Br.
Jacks Fork R.
Mahan's Cr.
Shawnee Cr.
4 0 4 Miles
N
Fish Collections
Watershed Inventory and Assessment 1997 Collection Site.
Missouri Aquatic Gap Project (MoRAP 2000)*
1981-2000
1961-1980
1941-1960
*Includes Missouri Department of Conservation and National Park Service collections.

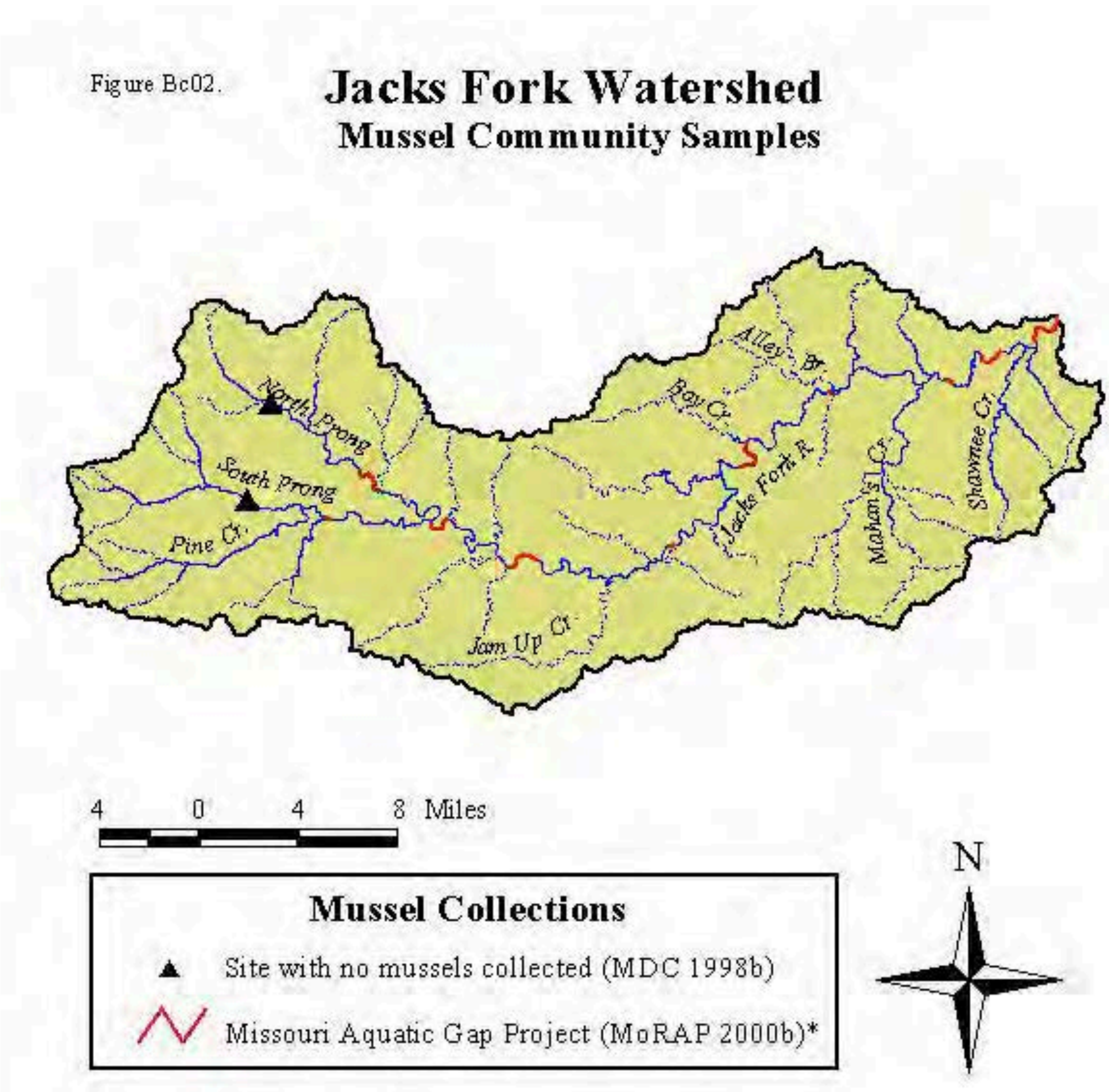


Figure Bc02.
Jacks Fork Watershed
Mussel Community Samples
North Prong
South Prong
Pine Cr.
Alley Br.
Bay Cr.
Jacks Fork R.
Mahan's Cr.
Shawnee Cr.
Jam Up Cr.
4 0 4 8 Miles
Mussel Collections
Site with no mussels collected (MDC 1998b)
Missouri Aquatic Gap Project (MoRAP 2000b)*
N

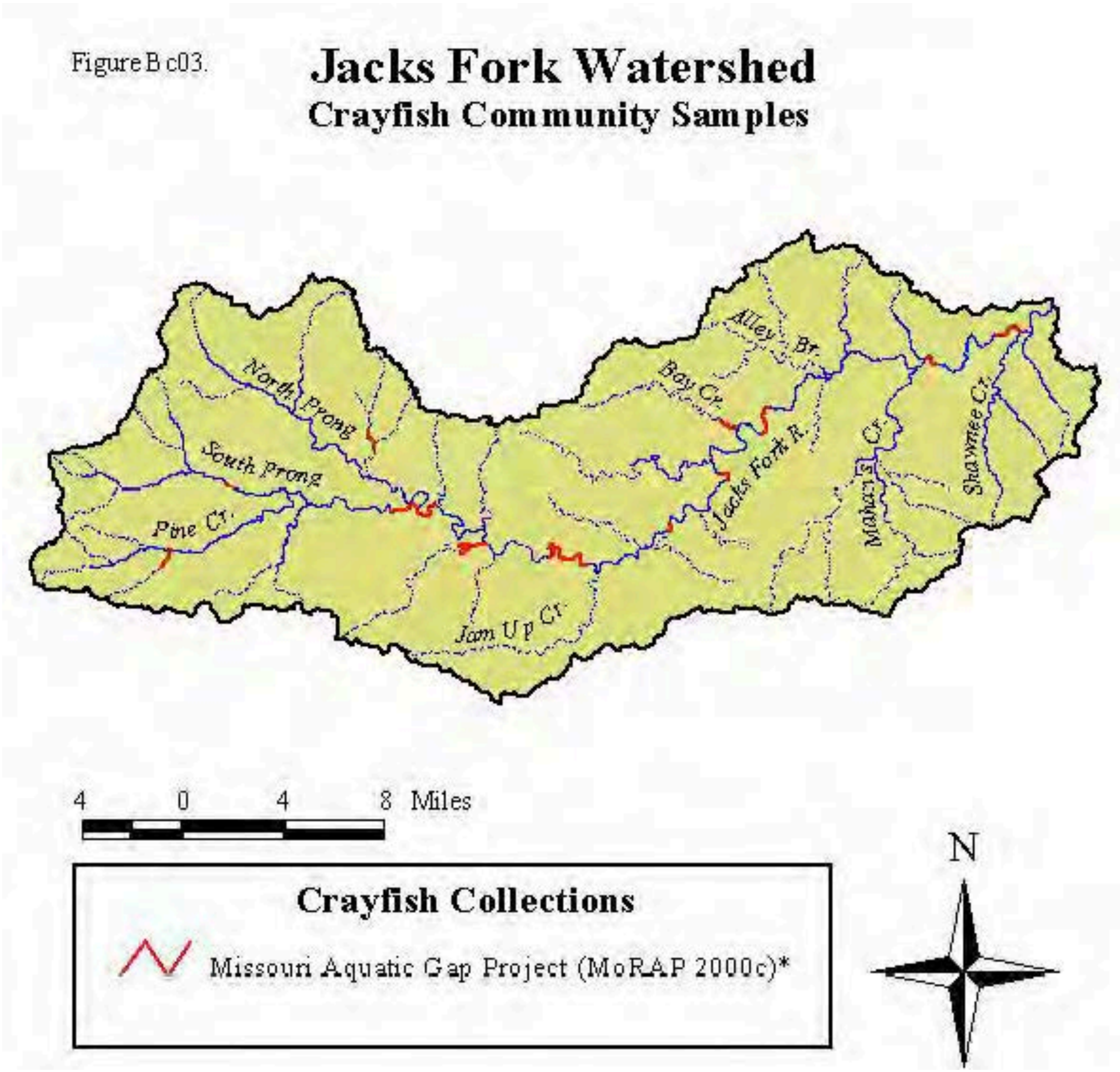


Figure B c03.
Jacks Fork Watershed
Crayfish Community Samples
North Prong
South Prong
Pine Cr.
Alley Br.
Bay Cr.
Jacks Fork R.
Mahans Cr.
Shawnee Cr.
Jam Up Cr.
4 0 4 8 Miles
Crayfish Collections
Missouri Aquatic Gap Project (MoRAP 2000c)*
N

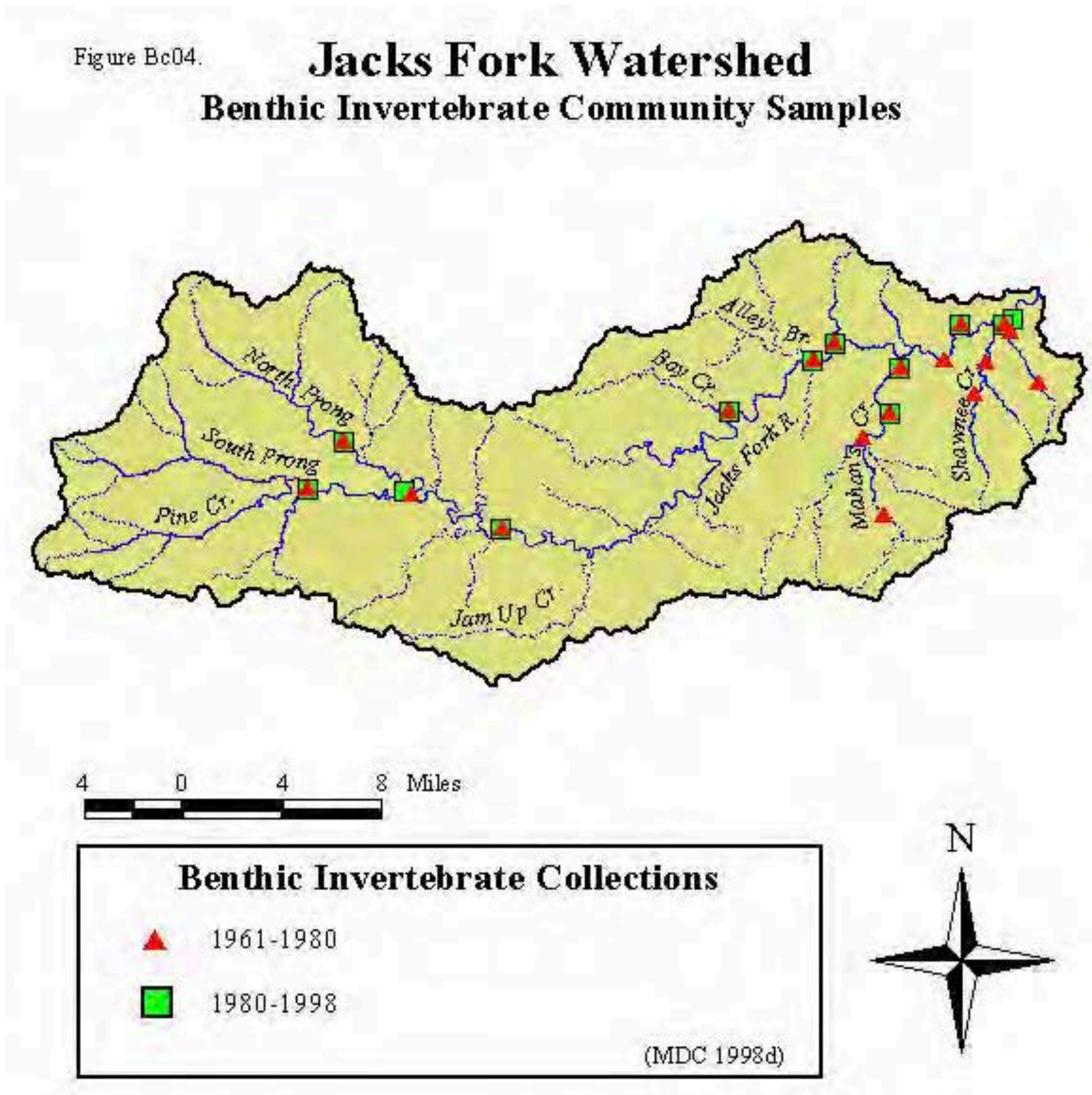


Figure Bc04.
Jacks Fork Watershed
Benthic Invertebrate Community Samples
Alley Br.
North Prong
Bay Cr.
South Prong
Jacks Fork R.
Mahans Cr.
Shawnee Cr.
Pine Cr.
Jam Up Cr.
4 0 4 8 Miles
Benthic Invertebrate Collections
1961-1980
1980-1998
(MDC 1998d)
N

Table Bc01. Fish species with a distribution range of the Jacks Fork Watershed (MDC Ozark (1 of 3) Regional Fish Collection Files; Pflieger 1989; Pflieger 1997; MDC 1999c; MoRAP 2000a).

Scientific Name	Common Name	Geographic Affinity	Sample Date
larval lamprey	O		
Ambloplites ariommus	shadow bass	O	1-2-3
Ameiurus melas	black bullhead	P	2
Ameiurus natalis	yellow bullhead	O,P	2-3
Anguilla rostrata	American eel	O,R	2
Aplodinotus grunniens	freshwater drum	WIDE	2
Campostoma anomalum	central stoneroller	O,P	1-2-3
Campostoma oligolepis	largescale stoneroller	O	1-2-3
Carassius auratus	goldfish	I	2
Catostomus commersoni	white sucker	O,P	2
Chaenobryttus gulosus	warmouth	L	2-3
Cottus carolinae	banded sculpin	O	1-2-3
Cottus hypselurus	Ozark sculpin	O	1-2-3
Cyprinella galactura	whitetail shiner	O	1-2-3
Cyprinus carpio	common carp	I	2
Dorosoma cepedianum	gizzard shad	WIDE	2
Erimystax harryi	Ozark chub	O	1-2-3
Erimyzon oblongus	creek chubsucker	O	1-2-3
Esox niger	chain pickerel	O	2-3
Etheostoma blennioides	greenside darter	O	1-2-3
Etheostoma caeruleum	rainbow darter	O	1-2-3
Etheostoma euzonum	Arkansas saddled darter	O	2-3
Etheostoma flabellare	fantail darter	O	2-3
Etheostoma uniporum	current darter	O,P	1-2-3
Etheostoma zonale	banded darter	O	1-2-3
Fundulus catenatus	northern studfish	O	1-2-3
Fundulus olivaceus	blackspotted topminnow	L,O	1-2-3
Hypentelium nigricans	northern hog sucker	O	1-2-3
Ichthyomyzon castaneus	chestnut lamprey	O,R	2
Ictiobus cyprinellus	bigmouth buffalo	R	2
Labidesthes sicculus	brook silverside	O	1-3
Lampetra aepyptera	least brook lamprey	O	2
Lampetra appendix	American brook lamprey	O	1-2
Lepisosteus osseus	longnose gar	WIDE	2-3
Lepomis cyanellus	green sunfish	WIDE	1-2-3
Lepomis macrochirus	bluegill	WIDE	1-2-3
Lepomis megalotis	longear sunfish	L,O	1-2-3
Lepomis miniatus	redspotted sunfish	L,O	1-2-3

Scientific Name	Common Name	Geographic Affinity	Sample Date
Luxilus chrysocephalus	striped shiner	O	1-2-3
Luxilus zonatus	bleeding shiner	O	1-2-3
Lythrurus umbratilis	redfin shiner	O,P,L	2-3
Micropterus dolomieui	smallmouth bass	O	1-2-3
Micropterus punctulatus	spotted bass	O,L	2
Micropterus salmoides	largemouth bass	WIDE	2-3
Minytrema melanops	spotted sucker	O,L	3-Feb
Moxostoma duquesnei	black redhorse	O	1/2/03
Moxostoma erythrurum	golden redhorse	O.P	1/2/03
Moxostoma macrolepidotum	shorthead redhorse	O	2
Nocomis biguttatus	hornyhead chub	O	1/2/03
Notemigonus crysoleucas	golden shiner	WIDE	1
Notropis amblops	bigeye chub	O	1/2/03
Notropis boops	bigeye shiner	O	1/2/03
Notropis greenei	wedgespot shiner	O	1/2/03
Notropis nubilus	Ozark minnow	O	1/2/03
Notropis ozarcanus	Ozark shiner	O	1/2/03
Notropis rubellus	rosyface shiner	O	1/2/03
Notropis telescopus	telescope shiner	O	1/2/03
Noturus albater	Ozark madtom	O	3-Feb
Noturus exilis	slender madtom	O	3-Feb
Noturus flavater	checkered madtom	O,L	2-3
Percina evides	gilt darter	O	1-2
Phoxinus erythrogaster	southern redbelly dace	O	2-3
Pimephales notatus	bluntnose minnow	WIDE	1-2-3
Polyodon spathula	paddlefish	R	2
Semotilus atromaculatus	creek chub	O,P	2-3
Stizostedion vitreum	walleye	O,R	2
Typhlichthys subterraneus	southern cavefish	O	3

Sample Date:1 = collected 1941 to 1960; 2 = collected 1961 to 1980; 3 = collected 1981 to 1997
Geographic Affinity: L=Lowland, O=Ozark, P=Prairie, R=Big River, Wide=Widely Distributed, I=Introduced

Table Bc02. Fish species distribution within the drainage units of the Jacks Fork Watershed (1 of 4) (MDC Ozark Regional Fish Collection Files; MDC 1999c; MoRAP 2000). Note: List does not include "species of conservation concern". No collections have been completed in the Lower South Prong, Jam Up Creek, or Leatherwood Units.

Common Name	Scientific Name	NP	USP	PC	JFBH	MJF	JFBC	MC	JFA	JFSC
American eel	*Anguilla rostrata*								X	X
Arkansas saddled darter	*Etheostoma euzonum*				X		X		X	
banded darter	*Etheostoma zonale*	X	X		X		X		X	X
banded sculpin	*Cottus carolinae*		X		X		X	X	X	X
bigeye chub	*Notropis amblops*	X	X					X	X	X
bigeye shiner	*Notropis boops*				X		X		X	X
bigmouth buffalo	*Ictiobus cyprinellus*								X	X
black bullhead	*Ameiurus melas*								X	
black redhorse	*Moxostoma duquesnei*							X	X	X
blackspotted topminnow	*Fundulus olivaceus*		X		X		X	X	X	X
bleeding shiner	*Luxilus zonatus*	X	X	X	X	X	X	X	X	X
bluegill	*Lepomis macrochirus*	X	X	X	X	X	X	X	X	X
bluntnose minnow	*Pimephales notatus*				X			X	X	X
brook silverside	*Labidesthes sicculus*				X					
central stoneroller	*Campostoma anomalum*	X	X	X	X	X	X	X	X	X
chain pickerel	*Esox niger*				X		X		X	X
chestnut lamprey	*Ichthyomyzon castaneus*								X	
common carp	*Cyprinus carpio*								X	X
creek chub	*Semotilus atromaculatus*	X		X	X		X	X		X
creek chubsucker	*Erimyzon oblongus*			X	X		X	X	X	
current darter	*Etheostoma uniporum*	X	X	X	X		X	X	X	X
fantail darter	*Etheostoma flabellare*	X	X				X	X	X	
freshwater drum	*Aplodinotus grunniens*									X
gilt darter	*Percina evides*								X	X
gizzard shad	*Dorosoma cepedianum*								X	X
golden redhorse	*Moxostoma erythrurum*							X	X	X
golden shiner	*Notemigonus crysoleucas*								X	
goldfish	*Carassius auratus*									X
green sunfish	*Lepomis cyanellus*	X	X		X		X	X	X	X
greenside darter	*Etheostoma blennioides*		X		X	X	X	X	X	X
hornyhead chub	*Nocomis biguttatus*	X	X	X	X	X	X	X	X	X
largemouth bass	*Micropterus salmoides*				X			X	X	X
largescale stoneroller	*Campostoma oligolepis*	X	X		X	X	X	X	X	X
larval lamprey								X		
least brook lamprey	*Lampetra aepyptera*						X	X	X	
longear sunfish	*Lepomis megalotis*	X	X	X	X	X	X	X	X	X
longnose gar	*Lepisosteus osseus*	X			X				X	X
northern hog sucker	*Hypentelium nigricans*	X	X	X	X	X	X	X	X	X
northern studfish	*Fundulus catenatus*	X	X	X	X	X	X	X	X	X
Ozark chub	*Erimystax harryi*	X	X	X	X	X	X	X		
Ozark madtom	*Noturus albater*	X	X	X	X	X	X	X		
Ozark minnow	*Notropis nubilus*	X	X	X	X	X	X	X	X	X
Ozark sculpin	*Cottus hypselurus*	X	X	X	X	X	X			

Common Name	Scientific Name	NP	USP	PC	JFBH	MJF	JFBC	MC	JFA	JFSC
rainbow darter	*Etheostoma caeruleum*	X	X	X	X	X	X	X	X	X
redfin shiner	*Lythrurus umbratilis*	X	X	X	X					
redspotted sunfish	*Lepomis miniatus*	X	X	X	X					
rosyface shiner	*Notropis rubellus*	X	X	X	X	X	X			
shadow bass	*Ambloplites ariommus*	X	X	X	X	X	X			
shorthead redhorse	*Moxostoma macrolepidotum*	X	X							
slender madtom	*Noturus exilis*	X	X	X	X	X	X	X	X	
southern redbelly dace	*Phoxinus erythrogaster*	X	X	X	X	X	X	X	X	
smallmouth bass	*Micropterus dolomieui*	X	X	X	X	X	X	X	X	X
spotted bass	*Micropterus punctulatus*	X								
spotted sucker	*Minytrema melanops*	X	X	X	X					
striped shiner	*Luxilus chrysocephalus*	X	X	X	X	X	X	X	X	X
telescope shiner	*Notropis telescopus*	X	X	X	X	X	X	X	X	
walleye	*Stizostedion vitreum*	X	X	X						
warmouth	*Chaenobryttus gulosus*	X	X							
wedgespot shiner	*Notropis greenei*	X	X	X	X	X				
white sucker	*Catostomus commersoni*	X								
whitetail shiner	*Cyprinella galactura*	X	X	X	X	X	X	X		
yellow bullhead	*Ameiurus natalis*	X	X	X	X					

NP=North Prong JFBH=Jacks Fork-Barn Hollow MC=Mahan's Creek USP=Upper South Prong MJF=Middle Jacks Fork JFA=Jacks Fork-Alley PC=Pine Creek JFBC=Jacks Fork-Bay Creek JFSC=Jacks Fork Shawnee Creek

Table Bc03. Fish Species of the Jacks Fork Watershed not collected in post 1980 samples.

Common Name	# of Sites Where Found Prior to 1981	# of Previous Sites Sampled 1981-1997	Sample Date
American brook lamprey	2	2	1-2
American eel	2	1	2
bigmouth buffalo	2	1	2
black bullhead	1	1	2
chestnut lamprey	1	1	2
common carp	2	2	2
freshwater drum	1	0	2
gilt darter	2	2	1-2
gizzard shad	2	1	2
golden shiner	1	1	1
goldfish	1	1	2
least brook lamprey	3	1	2
paddlefish	1	1	2
shorthead redhorse	2	1	2
spotted bass	1	1	2
walleye	2	1	2
white sucker	1	1	2

Sample Date:1 = collected 1941 to 1960; 2 = collected 1961 to 1980; 3 = collected 1981 to 1997

Table Bc04. Preliminary angler use and catch estimates from the Jacks Fork River Angler Survey MDC (1999b). Note: Survey is currently ongoing. Results from 1990 and 1991 currently unavailable. Standard error (SE95) is reported in parenthesis.

Area		Pre-Regulation			Post-Regulation			
		92	93	94	95	96	97	98
Treatment	Hours	12,794	9,451	7,274	3,395	2,120	2,096	3,278
	Trips	5,269 (±524)	4,566 (±404)	3,349 (±460)	1,210 (±160)	1,203 (±194)	525 (±109)	964 (±136)
	SMB	12,051	10,496	5,814	1,849	1,642	938	2,501
	SB	3,392	2,887	3,607	447	682	483	792
Non Treatment	Hours	2,908	3,333	2,854	1,568	4,267	1,325	1,269
	Trips	2,655 (±314)	3,274 (±370)	2,030 (±264)	644 (±118)	961 (±164)	1,038 (±269)	1,926 (±363)
	SMB	2,342	977	687	475	1,726	1,220	414
	SB	798	71	365	49	83	145	N/A

SMB-Smallmouth Bass
SB-Shadow Bass
N/A-Not available.

Table Bc05. Mussel distribution within the Jacks Fork Watershed (MoRAP 2000b, MDC 1999e).

Scientific Name	Common Name	L S P	N P	J F B H	M JF	JFBC	JFSC
Alasmidonta marginata	elktoe	Unavailable					
Alasmidonta viridis	slippershell mussel	X	X	X	X	X	
Amblema plicata	threeridge					X	
Corbicula fluminea	Asian clam					X	X
Elliptio dilatata	spike						X
Fusconaia ozarkensis	Ozark pigtoe	X	X	X	X	X	X
Lampsilis reeveiana brevicula	Ozark brokenray			X			
Lampsilis reeveiana reeveiana	Arkansas brokenray	Unavailable					
Lasmigona costata	flutedshell			X			
Leptodea fragilis	fragile papershell					X	
Ligumia subrostrata	pondmussel					X	X
Pleurobema sintoxia	round pigtoe						X
Ptychobranchus occidentalis	Ouachita kidneyshell	Unavailable					
Pyganodon grandis	giant floater					X	X
Strophitus undulatus	creeper	X	X				
Toxolasma lividus	Purple Lilliput	Unavailable					
Truncilla donaciformis	fawnsfoot				X		
Utterbackia imbecillis	paper pondshell					X	X
Villosa iris	rainbow	X		X	X	X	X

LSP=Lower South Prong **NP**=North Prong **JFBH**=Jacks Fork-Barn Hollow **MJF**=Middle Jacks Fork **JFBC**=Jacks Fork-Bay Cr. **JFSC**=Jacks Fork Shawnee Cr.

Table Bc06. Benthic invertebrate taxa of the Jacks Fork Watershed (MDC 1998d).

Order	Family	Species	Period
Amphipoda	Gammaridae		2
Amphipoda	Gammaridae	*Gammarus pseudolimnaeus* (Bousfield)	1,2
Amphipoda	Gammaridae	*Gammarus sp.*	2
Amphipoda	Gammaridae	*Gammarus fasciatus* (Say)	1,2
Amphipoda	Talitridae	*Hyalella azteca* (Saussure)	1,2
Coleoptera	Curculionidae	*Anchodemus sp.*	2
Coleoptera	Curculionidae	*Onychylis sp.*	1
Coleoptera	Dryopidae	*Helichus lithophilus* (Germar)	1,2
Coleoptera	Dryopidae	*Helichus basalis* (LeConte)	2
Coleoptera	Dryopidae	*Helichus sp.*	2
Coleoptera	Dytiscidae		2
Coleoptera	Dytiscidae	*Dytiscus sp.*	1
Coleoptera	Dytiscidae	*Hydroporus niger* (Say)	1
Coleoptera	Elmidae		2
Coleoptera	Elmidae	*Ancyronyx variegata* (Germar)	1
Coleoptera	Elmidae	*Dubiraphia sp.*	2
Coleoptera	Elmidae	*Dubiraphia vittata* (Melsheimer)	2
Coleoptera	Elmidae	*Dubiraphia bivittata* (LeConte)	1
Coleoptera	Elmidae	*Macronychus glabratus* (Say)	1,2
Coleoptera	Elmidae	*Microcylloepus pusillus pusillus* (LeConte)	2
Coleoptera	Elmidae	*Optioservus sandersoni* (Collier)	1,2
Coleoptera	Elmidae	*Stenelmis bicarinata* (LeConte)	2
Coleoptera	Elmidae	*Stenelmis beameri* (Sanderson)	2
Coleoptera	Elmidae	*Stenelmis crenata* (Say)	2
Coleoptera	Elmidae	*Stenelmis exigua* (Sanderson)	2
Coleoptera	Elmidae	*Stenelmis lateralis* (Sanderson)	2
Coleoptera	Elmidae	*Stenelmis cheryl* (Brown)	2
Coleoptera	Elmidae	*Stenelmis sp.*	1,2
Coleoptera	Gyrinidae	*Dineutus sp.*	2
Coleoptera	Hydrophilidae		1,2
Coleoptera	Hydrophilidae	*Enochrus sp.*	2

Order	Family	Species	Period
Coleoptera	Hydrophilidae	*Tropisternus sp.*	2
Coleoptera	Limnicidae	*Lutrochus laticeps* (Casey)	1,2
Coleoptera	Psephinidae	*Ectopria nervosa (Melsheimer)*	
Coleoptera	Psephinidae	*Psephenus herricki* (DeKay)	1,2
Decapoda	Cambaridae	*Orconectes sp.*	1,2
Diptera	Athericidae	*Atherix lantha* (Webb)	1,2
Diptera	Ceratopogonidae		1
Diptera	Ceratopogonidae	*Atrichopogon sp.*	1,2
Diptera	Ceratopogonidae	*Bezzia/Probezzia.*	1,2
Diptera	Chironomidae		1,2
Diptera	Empididae		1,2
Diptera	Muscidae		1,2
Diptera	Psychodidae		2
Diptera	Simuliidae		1,2
Diptera	Simuliidae	*Simulium sp.*	2
Diptera	Stratiomyidae		1
Diptera	Stratiomyidae	*Oxycera sp.*	2
Diptera	Tabanidae		1,2
Diptera	Tabanidae	*Chrysops sp.*	2
Diptera	Tanyderidae	*Protoplasa fitchii* (Osten-Sacken)	1,2
Diptera	Tipulidae	*Antocha sp.*	1,2
Diptera	Tipulidae	*Hexatoma sp.*	1,2
Diptera	Tipulidae	*Limonia sp.*	2
Diptera	Tipulidae	*Tipula sp.*	1,2
Diptera	Tipulidae	*Tipulidae*	1,2
Ephemeroptera	Baetidae	*Acentrella sp.*	1,2
Ephemeroptera	Baetidae	*Baetis sp.*	2
Ephemeroptera	Baetidae	*Baetis tricaudatus* (Dodds)	1,2
Ephemeroptera	Baetiscidae	*Baetisca lacustris* (McDunnough)	1
Ephemeroptera	Baetiscidae	*Baetisca sp.*	2
Ephemeroptera	Caenidae	*Caenis sp.*	1,2
Ephemeroptera	Ephemerellidae	*Ephemerella (invaria grp.)*	1
Ephemeroptera	Ephemerellidae	*Ephemerella subvaria* (McDunnough)	2
Ephemeroptera	Ephemerellidae	*Ephemerella sp.*	2
Ephemeroptera	Ephemerellidae	*Eurylophella* (bicolor grp.)	1
Ephemeroptera	Ephemerellidae	*Eurylophella sp.*	2
Ephemeroptera	Ephemerellidae	*Eurylophella bicolor* (Clemens)	2
Ephemeroptera	Ephemerellidae	*Serratella deficiens* (Morgan)	2

Order	Family	Species	Period
Ephemeroptera	Ephemerellidae	*Serratella* (serrata grp.)	2
Ephemeroptera	Ephemerellidae	*Serratella sp.*	1
Ephemeroptera	Ephemeridae	*Ephemera sp.*	2
Ephemeroptera	Ephemeridae	*Ephemera guttulata* (Pictet)	1,2
Ephemeroptera	Heptageniidae	*Heptagenia sp.*	1,2
Ephemeroptera	Heptageniidae	*Leucrocuta sp.*	2
Ephemeroptera	Heptageniidae	*Rhithrogena sp.*	2
Ephemeroptera	Heptageniidae	*Rhithrogena pellucida* (Daggy)	1,2
Ephemeroptera	Heptageniidae	*Stenacron sp.*	2
Ephemeroptera	Heptageniidae	*Stenacron gildersleevei* (Traver)	1
Ephemeroptera	Heptageniidae	*Stenacron (interpunctatum grp.)*	1,2
Ephemeroptera	Heptageniidae	*Stenonema vicarium* (Walker)	1
Ephemeroptera	Heptageniidae	*Stenonema pulchellum* (Walsh)	1,2
Ephemeroptera	Heptageniidae	*Stenonema terminatum* (Walsh)	2
Ephemeroptera	Heptageniidae	*Stenonema bednariki* (McCafferty)	1,2
Ephemeroptera	Heptageniidae	*Stenonema femoratum (Say)*	1,2
Ephemeroptera	Heptageniidae	*Stenonema mediopunctatum* (McDunnough)	1,2
Ephemeroptera	Isonychiidae	*Isonychia sp.*	1,2
Ephemeroptera	Leptophlebiidae		1,2
Ephemeroptera	Leptophlebiidae	*Choroterpes sp.*	2
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia moerens* (McDunnough)	1
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia praepedita* (Eaton)	1
Ephemeroptera	Potamanthidae	*Anthopotamus sp.*	1,2
Ephemeroptera	Tricorythidae	*Tricorythodes sp.*	1,2
Gordiida			1,2
Hemiptera	Corixidae	*Sigara mathesoni* (Hungerford)	2
Hemiptera	Gerridae	*Gerris remigis Say*	2
Hemiptera	Gerridae	*Metrobates hesperius* (Uhler)	2
Hemiptera	Gerridae	*Rheumatobates sp.*	1
Hemiptera	Veliidae		1
Hemiptera	Veliidae	*Microvelia americana* (Uhler)	2

Order	Family	Species	Period
Hemiptera	Veliidae	*Rhagovelia sp.*	1,2
Hirudinea2			1,2
Hirudinea2	Branchiobdellidae[1]		1,2
Hydracarina	Acari		1,2
Isopoda	Asellidae	*Caecidotea sp.*	1,2
Lepidoptera	Pyralidae	*Petrophila sp.*	1,2
Lymnophila	Ancylidae	*Ferrissia fragilis (Tryon)*	1,2
Lymnophila	Ancylidae	*Ferrissia sp.*	2
Lymnophila	Lymnaeidae	*Lymnaea (Stagnicola) sp.*	2
Lymnophila	Physidae		1
Lymnophila	Physidae	*Physa* (Physella) *sp.*	2
Lymnophila	Planorbidae		2
Megagastropoda	Pleuroceridae	*Elimia potosiensis potosiensis* (Lea)	2
Megagastropoda	Pleuroceridae	*Elimia potosiensis plebeius* (Gould)	1,2
Megagastropoda	Pleuroceridae	*Elimia sp.*	2
Megaloptera	Corydalidae	*Corydalus cornutus* (Linnaeus)	1,2
Megaloptera	Corydalidae	*Nigronia fasciatus* (Walker*)*	2
Megaloptera	Corydalidae	*Nigronia serricornis* (Say)	1,2
Megaloptera	Sialidae	*Sialis sp.*	1,2
Nemata3			1,2
Odonata	Calopterygidae	*Calopteryx maculata* (Beauvois)	2
Odonata	Calopterygidae	*Hetaerina sp.*	2
Odonata	Coenagrionidae		1
Odonata	Coenagrionidae	*Argia sp.*	2
Odonata	Coenagrionidae	*Argia moesta* (Hagen)	2
Odonata	Coenagrionidae	*Argia sedula* (Hagen)	2
Odonata	Gomphidae		1,2
Odonata	Gomphidae	*Gomphus sp.*	2
Odonata	Gomphidae	*Stylogomphus albistylus* (Hagen)	2
Oligochaeta			1,2
Plecoptera	Capniidae		1
Plecoptera	Capniidae	*Allocapnia sp.*	1,2
Plecoptera	Capniidae	*Paracapnia sp.*	1
Plecoptera	Leuctridae		1,2
Plecoptera	Leuctridae	*Leuctra sp.*	2
Plecoptera	Leuctridae	*Leuctra tenuis* (Pictet)	2
Plecoptera	Nemouridae		1,2
Plecoptera	Nemouridae	*Nemoura sp.*	2
Plecoptera	Perlidae		2

Order	Family	Species	Period
Plecoptera	Perlidae	*Acroneuria sp.*	1,2
Plecoptera	Perlidae	*Agnetina capitata* (Pictet)	1
Plecoptera	Perlidae	*Neoperla sp.*	2
Plecoptera	Perlidae	*Neoperla clymene (Newman)*	1,2
Plecoptera	Perlidae	*Paragnetina media* (Walker)	1
Plecoptera	Perlidae	*Paragnetina sp.*	2
Plecoptera	Perlidae	*Perlesta placida* (Hagen)	1,2
Plecoptera	Perlidae	*Perlinella sp.*	2
Plecoptera	Perlidae	*Perlinella drymo* (Newman*)*	1
Plecoptera	Perlodidae	*Hydroperla crosbyi* (Needham & Claassen*)*	2
Plecoptera	Perlodidae	*Hydroperla sp.*	1
Plecoptera	Perlodidae	*Isoperla marlynia* (Needham & Claassen)	1
Plecoptera	Perlodidae	*Isoperla bilineata* (Say)	1
Plecoptera	Perlodidae	*Isoperla signata* (Banks)	1
Plecoptera	Pteronarcyidae	*Pteronarcys pictetii* (Hagen)	1
Plecoptera	Pteronarcyidae	*Pteronarcys sp.*	2
Plecoptera	Taeniopterygidae	*Strophopteryx fasciata* (Burmeister)	1
Plecoptera	Taeniopterygidae	*Taeniopteryx sp.*	2
Plecoptera	Taeniopterygidae	*Taeniopteryx metequi* (Ricker & Ross)	1
Trichoptera	Brachycentridae	*Brachycentrus sp.*	2
Trichoptera	Brachycentridae	*Brachycentrus americanus* (Banks)	1
Trichoptera	Brachycentridae	*Micrasema rusticum* (Hagen)	2
Trichoptera	Glossosomatidae		2
Trichoptera	Glossosomatidae	*Glossosoma sp.*	2
Trichoptera	Helicopsychidae	*Helicopsyche borealis* (Hagen)	1,2
Trichoptera	Hydroptilidae	*Agraylea multipunctata* (Curtis)	1,2
Trichoptera	Hydropsychidae	*Ceratopsyche* (morosa grp.)	1,2
Trichoptera	Hydropsychidae	*Ceratopsyche morosa* (Hagen)	2
Trichoptera	Hydropsychidae	*Cheumatopsyche sp.*	1,2
Trichoptera	Hydropsychidae	*Hydropsyche betteni* (Ross)	1,2
Trichoptera	Hydropsychidae	*Hydropsyche cuanis* (Ross)	1

Order	Family	Species	Period
Trichoptera	Hydropsychidae	*Hydropsyche simulans/incommoda*	2
Trichoptera	Hydropsychidae	*Hydropsyche sp.*	2
Trichoptera	Hydroptilidae		2
Trichoptera	Hydroptilidae	*Hydroptila sp.*	2
Trichoptera	Lepidostomatidae		1,2
Trichoptera	Lepidostomatidae	*Lepidostoma sp.*	2
Trichoptera	Limnephilidae		1,2
Trichoptera	Limnephilidae	*Limnephilus sp.*	1
Trichoptera	Limnephilidae	*Neophylax fuscus* (Banks)	1,2
Trichoptera	Limnephilidae	*Pycnopsyche sp.*	2
Trichoptera	Philopotamidae	*Chimarra sp.*	2
Trichoptera	Philopotamidae	*Chimarra obscura* (Walker)	1,2
Trichoptera	Philopotamidae	*Chimarra aterrima* (Hagen)	1,2
Trichoptera	Polycentropodidae	*Cyrnellus sp.*	2
Trichoptera	Polycentropodidae	*Neureclipsis sp.*	2
Trichoptera	Polycentropodidae	*Polycentropus sp.*	1,2
Trichoptera	Psychomyiidae	*Lype diversa (Banks)*	2
Trichoptera	Psychomyiidae	*Psychomyia flavida* (Hagen)	2
Trichoptera	Rhyacophilidae		1
Tricladida	Planariidae		1,2
Tricladida	Planariidae	*Dugesia sp.*	2
Unionoida	Unionidae	*Elliptio sp.*	1
Unionoida	Unionidae	*Fusconaia ozarkensis* (Call)	2
Unionoida	Unionidae	*Lampsilis reeviana brittsi (Simpson)*	2
Unionoida	Unionidae	*Lampsilis reeviana brevicula* (Call)	1
Veneroida	Sphaeriidae		1,2
Veneroida	Sphaeriidae	*Sphaerium sp.*	2

Period: 1=1961-1974, 2=1975-1992 [1] Subclass, [2] Class, [3] Phylum

Table Bc07. Species of conservation concern within the Jacks Fork Watershed (MDC Ozark (1 of 3) Regional Fish Collection Files, Pflieger 1996; MDC 1998c; MDC 1999c; MDC 1999d, MoRAP 2000a, MoRAP 2000b).

Scientific Name	Common Name	Grank	Srank	M	F	Year
Mammals						
Myotis grisescens	gray bat	S3	G3	E	E	1994
Ochrotomys nuttalli	golden mouse	S3?	G5			1988
Birds						
Accipiter striatus	sharp-shinned hawk	S2	G5			1986
Aimophila aestivalis	Bachman's sparrow	S1	G3	E	*	1991
Ardea herodias	great blue heron	S5	G5			1995
Amphibians						
Cryptobranchus alleganiensis bishopi	Ozark hellbender	S2	G4T3		*	1992
Hemidactylium scutatum	four-toed salamander	S4	G5			1980
Fish						
Lampetra appendix	American brook lamprey	S2	G4			1962
Notropis ozarcanus	Ozark shiner	S2	G3		*	1997
Noturus flavater	checkered madtom	S3S4	G4			1997
Polydon spathula	paddlefish	S3	G4		*	1966
Typhlichthys subterraneus	southern cavefish	S2S3	G3			1992
Mussels						
Alasmidonta marginata	elktoe	S2?	G4		*	1982
Lampsilis reeveiana reeveiana	Arkansas brokenray	S2?	G3T1T2			1982
Ptychobranchus occidentalis	Ouachita kidneyshell	S2S3	G3G4		*	1982
Toxolasma lividus	purple llliput	S2	G2		*	1982
Crayfish						
Cambarus hubrichti	Salem cave crayfish	S3	G2			N/A
Insects						
Hydropsyche piatrix	a net-spinning caddisfly	S4	G?			1988
Stenonema bednariki McCafferty	a heptageniid mayfly	S3	G?			1989
Plants, Ferns, Fern Allies, and Mosses						
Aster furcatus	forked aster	S2	G3		*	1985
Aster macrophyllus	big-leaved aster	S2	G5			1990
Barbula convoluta var. convoluta	a moss	S?	G5T?			1963
Berberis canadensis	American barberry	S2	G3			1992

Scientific Name	Common Name	Grank	Srank	M	F	Year
Bromus nottowayanus	a brome	S2S3	G3G4			1932
Calamagrostis porteri ssp. insperata	reed bent grass	S3	G4T3		*	1990
Campanula rotundifolia	harebell	S1	G5			1984
Carex alata	broadwing sedge	S2S3	G5			1990
Carex albicans var. australis	bellow beaked sedge	S1	G5T5			1983
Carex comosa	bristly sedge	S2	G5			1987
Carex decomposita	epiphytic sedge	S3	G3			1997
Carex stricta	tussock sedge	S2?	G5			1983
Carex vesicaria var. monile	a sedge	S2?	G5T4			1987
Cypripedium candidum	small white lady-slipper	S1	G4			1993
Cypripedium reginae	showy lady-slipper	S2S3	G4			1987
Plants, Ferns, Fern Allies, and Mosses (continued)						
Delphinium exaltatum	tall larkspur	S2	G3		*	1985-
Didymodon revolutus	a moss	S1	G4			1938
Galium boreale ssp. septentrionale	northern bedstraw	S2	G5T?			1987
Geum virginianum	pale avens	S1	G5			1991
sharp-scaled manna grass	Glyceria acutiflora	S3	G5			1936
Gratiola viscidula	hedge hyssop	S1	G4G5			1975
Sharp's homaliadelphus	Homaliadelphus sharpii	S1	G3			1970
Lemna trisulca	star duckweed	S2	G5			1987
Liparis loeselii	Loesel's twayblade	S2	G5			1984
Nowellia curvifolia	a liverwort	S?	G5			1938
Platanthera flava	rein orchid	S2	G4T4Q			1928
Potamogeton pulcher	spotted pondweed	S2S3	G5			1932
Rhytidiadelphus triquetrus	shaggy moss	S?	G5			1970
Rhytidium rugosum	golden glade-moss	S1	G5			1973
Trautvetteria caroliniensis	false bugbane	S2	G5			1985
Waldsteinia fragarioides ssp. fragar	barren strawberry	S2	G5T5			1985
Zigadenus elegans	white camas	S2	G5			1987

Year=Last year observed at site

F=Federal Status
M=Missouri Status
E=Endangered
T=Threatened
* =Former category-2 candidate (In December of 1996, the USFWS discontinued the practice of maintaining a list of species regarded as "category-2 candidates". MDC continues to distinguish these species for information and planning purposes.
S=State Status
E=Endangered

SRrank

S1=Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. (typically 5 or fewer occurrences or very few remaining individuals)
S2=Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. (6 to 20 occurrences or few remaining individuals or acres)
S3=Rare and uncommon in the state. (21 to 100 occurrences)
S4=Widespread, abundant, and apparently secure in state, with many occurrences, but the species is of long-term concern. (usually more than 100 occurrences)
S5=Demonstrably widespread, abundant, and secure in the state, and essentially ineradicable under present conditions.
SU=Unrankable: Possibly in peril in the state, but status uncertain; need more information.
SE=Exotic: An exotic established in the state; may be native in nearby regions.
SH=Historical: Element occurred historically in the state (with expectation that it may be rediscovered).
Perhaps having not been verified in the past 20 years, and suspected to be still extant.
S?=Unranked: Species is not yet ranked in the state.
Qualifier:
? =Inexact or uncertain: for numeric ranks, denotes inexactness. (The ? qualifies the character immediately
preceding it in Srank)

Grank

G1=Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. (typically 5 or fewer occurrences or very few remaining individuals or acres)
G2=Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction throughout its range. (6 to 20 occurrences or few remaining individuals or acres)
G3=Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range. (21 to 100 occurrences)
G4=Widespread, abundant, and apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery. Thus, the element is of long-term concern. (usually more than 100 occurrences)

G5=Demonstrably Widespread, abundant, and secure globally, though it may be quite rare in parts of its range, especially at the periphery.

Subrank

T=Taxonomic subdivision: rank applies to subspecies or variety.
Qualifier:
? =Inexact: denotes inexact numeric rank.
Q=Questionable taxonomy: taxonomic status is questionable; numeric rank may change with taxonomy.
Note: Data in table subject to revision. This table is not a final authority.

Management Problems and Opportunities

The management goals, objectives, and strategies for the Jacks Fork Watershed were developed using information collected from the Jacks Fork Watershed Assessment and Inventory (WAI) and direction provided by the Ozark Regional Management Guidelines (1998), Missouri Department of Conservation (MDC) Strategic Plan, and the Fisheries Division Five Year Strategic Plan (1995-2000). Objectives and strategies were written for instream and riparian habitat, water quality, aquatic biota, recreational use, and hydrography. All goals are of equal importance, with objectives listed in prioritized order whenever possible. This plan includes only those activities and results that can reasonably expected to be achieved or influenced during the next 25 years. Completion of these objectives will depend upon their status in overall regional and division priorities and the availability of human resources and funds.

Goal I: Improve riparian and aquatic habitats in the Jacks For Watershed.

Status: Problems affecting riparian and aquatic habitats include insufficient wooded riparian corridors, stream bank erosion, gravel dredging, and other point and non-point sources of pollution. Protecting and enhancing the riparian corridor is essential to obtaining quality aquatic habitats. A timbered stream corridor significantly influences many components of the stream ecosystem including stream bank stability, water quality, ground water absorption and recharge to the stream, amount of physical instream habitat, spatial and structural complexity of physical instream habitat, and the food web.

Objective 1.1: With the assistance of willing landowners, over a 25-year period, increase by 25% the proportion of streams with a timbered corridor width >100 feet.

Strategy: Referencing the riparian corridor improvement benefit potential ranking for drainage units of the Jacks Fork Watershed presented in Figure Mp01 (developed through evaluations of riparian forest cover absence, losing streams, unit size, and presence of sensitive species), direct appropriate riparian corridor improvement efforts towards the following ranked drainage units: High= North Prong, Jacks Fork-Shawnee Creek, Jam Up Creek, and Jacks Fork-Barn Hollow; Medium= Mahan's Creek, Upper South Prong; Low= Lower South Prong, Middle Jacks Fork, Pine Creek, Jacks Fork-Alley, Jacks Fork-Bay Creek, and Leatherwood.

- Using videotapes, field investigations, aerial photography, and satellite imagery, document and update the current and future conditions of riparian corridors and stream banks once every 10 years. Future projects such as the Missouri Resource Assessment Partnership Land Cover Classification need to be encouraged in order to ensure that adequate data is available to will allow efficient analysis of riparian corridor conditions over time.
- Ensure all MDC Areas represent examples of proper riparian corridor stewardship by following established best management practices for riparian restoration/protection.
- In cooperation with regional Private Land Services Division personnel, provide appropriate agencies such as Natural Resources Conservation Service (NRCS) and Soil and Water Conservation Districts (SWCDs) as well as willing agricultural-oriented businesses such as farm centers, agricultural chemical dealers, etc. with free brochures dealing with riparian corridor issues in order to facilitate increased awareness and dissemination of this information to landowners.

- Use available cost-share funding and/or provide technical assistance in order to facilitate riparian corridor restoration/protection by willing landowners in accordance with appropriate cost-share guidelines.

Objective 1.2: Limit the negative impacts of sand and gravel removal within the watershed.

Strategy: Education of gravel operators regarding limiting the effects of sand and gravel removal and the potential negative impacts associated with gravel removal, dynamic documentation of permitted sand and gravel removal sites, assisting with continued research regarding gravel removal, and encouragement of the efficient enforcement of violations associated with sand and gravel removal will be important in limiting the potential negative impacts of gravel removal.

- Work with gravel removal operators as well as willing landowners in identifying appropriate gravel removal sites.
- Work with appropriate agencies to develop a geographic information system (GIS)
- database (to be updated annually) of permitted sand and gravel removal sites as well as a database of appropriate potential sand and gravel removal sites (updated every 10 years).
- Continue to assist appropriate state and federal agencies in the enforcement of existing water quality laws in regard to sand and gravel removal.
- Assist with additional research efforts regarding the effects of instream sand and gravel removal in order to develop measures that adequately protect aquatic resources.

Goal II: Improve surface and ground water quality in the Jacks Fork watershed.

Status: Water quality within the watershed is relatively good. However, potential threats include Large numbers of livestock in riparian zones for extended periods of time, private septic system failure, increased nutrients from municipal sewage treatment facilities and poor land use practices such as indiscriminate land clearing, these can result in periodic high fecal coliform levels, nutrient loading, and sediment and gravel deposition.

Objective 1.1: Ensure that watershed streams meet or exceed state standards for water quality.

Strategy: Due to the connection between the surface water and ground water systems in the watershed, protection of surface waters, both permanent and intermittent, can also greatly contribute to the enhancement of ground water quality. Protecting riparian corridors will reduce surface runoff and provide stream bank and channel stability. Streams also need protection from other pollutants. Education of the citizenry and land owners on water quality issues and land stewardship is the best hope for improving water quality. Encouragement of appropriate agencies to enforce existing water quality laws is also required to obtain satisfactory water quality.

- Through media contacts, personal contacts, literature development, and speaking engagements to groups such as area Stream Teams and land owners, inform the public of water quality issues and problems (e.g. karst topography, excessive siltation, animal waste runoff, gravel dredging, septic system failure etc.) and best management practices to address these problems.
- Encourage structured water quality sampling by continuing to assist with training and involvement of Stream Teams in water quality monitoring and advocacy within the watershed.
- Conduct a fish and mussel contaminant sample within the watershed by 2005.

- Encourage and assist with additional dye tracing studies within the watershed in order to further determine intrawatershed and interwatershed ground water movement as well as recharge area of selected springs within the watershed with an emphasis on publicly owned spring outlets.
- Encourage and assist with enforcement of existing water quality laws by reviewing 404 permits, cooperating with other state and federal agencies to investigate pollution and fish kill reports, collecting water quality related data, and recommending measures to protect aquatic communities.
- Encourage the entry of water quality data into a GIS compatible format in order to facilitate effective data updating and analysis. This includes the creation of a 'Designated Use' data layer based on current Rule 10 CSR 20-7.031 of the Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality, Tables G and H.
- In cooperation with regional private lands services personnel, encourage limiting livestock access in riparian areas and through education and/or incentive programs for private landowners.

Goal III: Maintain the abundance, diversity, and distribution of aquatic biota at or above current levels while improving the quality of the game fishery in the Jacks fork watershed.

Status: Since 1941, an assemblage of 67 fish species, 19 mussel species, 5 crayfish species, and 200 taxa of benthic macro-invertebrates have been identified throughout the Jacks Fork Watershed. A total of 51 "species of conservation concern" are known to occur in the watershed. This list includes 5 fish species, 4 species of mussels; 2 species of amphibian, and 1 species of crayfish. The most prominent game fish species within the watershed include the shadow bass, smallmouth bass, and largemouth bass. In addition, sucker species provide an alternative recreational opportunity. Exotic aquatic species within the watershed include the Asian clam, the common carp and goldfish.

Objective 1.1: Maintain the diversity, abundance, and distribution of native non-sport fish, and aquatic invertebrate communities at or above current levels.

Strategy: High priority should be placed on protecting "species of conservation concern" and unique community assemblages. Focusing enhancement and protective efforts on a few species can be effective in helping other species that share the same habitat. Detecting changes in faunal composition and abundance can be accomplished by conducting routine surveys of fish and invertebrate communities.

Determining reasons for any changes will be more difficult since a variety of factors (e.g. interspecific and intraspecific competition, water quality, habitat condition, etc.) could be involved.

- Assist with recovery efforts for "species of conservation concern within the watershed.
- Survey fish communities in the watershed every 10 years at historical sampling sites using standardized sampling techniques. Establish additional sampling sites as necessary with high priority given to MDC areas. Incorporate data into GIS in order to facilitate documentation of changes in species diversity, abundance, and/or distribution.
- Using GIS, document locations and identify unique fish assemblages associated with natural features and special habitats such as spring branches for inclusion in the Natural Heritage Database.
- Develop a prioritized list of streams and stream reaches needing habitat restoration using the following criteria: presence of listed species, extent of timbered stream corridor, size of stream, land use, soils, presence of permanent water, presence of sport fish, natural features, critical habitat, etc

- If appropriate, recommend research projects in cooperation with MDC Research Staff to investigate reasons for significant changes in faunal abundance and distribution. Recommend management changes if needed.
- Coordinate with MDC Research Staff and other groups (i.e. National Park Service, University of Missouri, etc.) to develop a routine mussel survey schedule for the watershed.
- Coordinate with MDC Research Staff and other groups (i.e. National Park Service, Missouri Department of Natural Resources, University of Missouri, etc.) to conduct a survey of benthic invertebrates on all fifth order and larger streams.

Objective 1.2: Maintain or improve populations of sport fish while maintaining a stable and diverse fish community.

Strategy: Proper management of game fish populations will depend on obtaining adequate surveys to determine the status of the fishery and angler attitudes as well as implementing habitat improvement projects, regulation changes, and fish stocking where needed. The Jacks Fork River from Highway 17 to Highway 106 is currently (2000) managed under special smallmouth regulations as part of a smallmouth bass research project currently being conducted by the MDC. An angler survey has been ongoing since 1990 on the Jacks Fork River in order to determine the effect of the special smallmouth bass regulation on angling success, angler acceptance of the regulation, and economic value of the fishery. Once adequate information is obtained, future management efforts will be directed toward setting appropriate fishing regulations and protecting and improving fish habitat.

1. Upon completion of the current smallmouth bass research project, implement appropriate management activities for the Jacks Fork River in cooperation with the National Park Service and other appropriate government as well as private entities.
2. With approval from appropriate agencies (i.e. National Park Service, United States Army Corps of Engineers, etc.), implement stream habitat improvement projects in stream segments of heavy angler pressure which otherwise lack sufficient stream habitat with priority given to public areas.

Objective 1.3: Prevent detrimental impacts on native fauna of the Jacks Fork Watershed by exotic aquatic species.

Strategy: Controlling the introduction of exotic species into the state is the easiest way to prevent detrimental impacts to native fauna. Once a detrimental exotic species becomes established, research will be needed to seek ways to contain or eliminate exotic species.

1. Continue division participation in the Missouri Aquaculture Advisory Council (MAAC) and other organizations and advocate controlling the introduction of exotic fauna into state waters.
2. Monitor for potentially harmful exotic species (i.e., zebra mussel, common carp, etc.). This can be performed during fish community surveys.
3. Educate anglers on the potential damaging effects of ‘bait bucket’ introductions to lake and stream communities by the use of flyers posted at accesses.
4. Participate in statewide efforts to control exotic species in the Jacks Fork Watershed.

Goal IV: Increase public awareness and promote wise use of aquatic resources in the Jacks Fork watershed.

Status: Angler survey information indicates that from 1992 to 1998 an average of 4,231 trips annually were spent angling on the Jacks Fork River and its tributaries. Floating is also a popular activity within the watershed. Heavy floater densities in the past years prompted the National Park Service to establish maximum canoe use levels as part of a river use management plan in

1985. This plan divided the Jacks Fork River into two zones: the confluence of the North and South Prongs to Alley Spring (24.5 miles) and Alley Spring to Two Rivers (14.9 miles). Both Zones were designated for medium canoe use (11-40 canoes per mile) during all time periods. A 1997 recreational use survey was conducted on the Jacks Fork River with a total of 3,734 watercraft including innertubes being counted. Canoes were the most prevalent watercraft, accounting for approximately 89% of the total watercraft.

Objective 4.1: Ensure that up to date aquatic oriented recreational data is available in order to assist in properly managing aquatic resources and their use.

Strategy: Encourage and assist appropriate agencies in the continued monitoring of aquatic oriented recreational activities within the watershed on a regular basis in order to provide data to be used for determining long term trends and problems which may need to be addressed through adjustments in management.

- In cooperation with the MDC Biometrics Staff and the National Park Service, explore options to measure angler perceptions and satisfaction.
- Encourage the continued monitoring of river use on a regular basis as set forth in the Ozark National Scenic Riverways River Use Management Plan.
- In cooperation with MDC Fisheries Research and Biometrics Staff, develop a routine angler survey program for the Jacks Fork River to be conducted every 10 years.

Objective 4.2: Increase awareness of stream recreational opportunities and appreciation of stream ecology and advocacy to a level that will encourage a widespread and diversified public interest in the Jacks Fork Watershed.

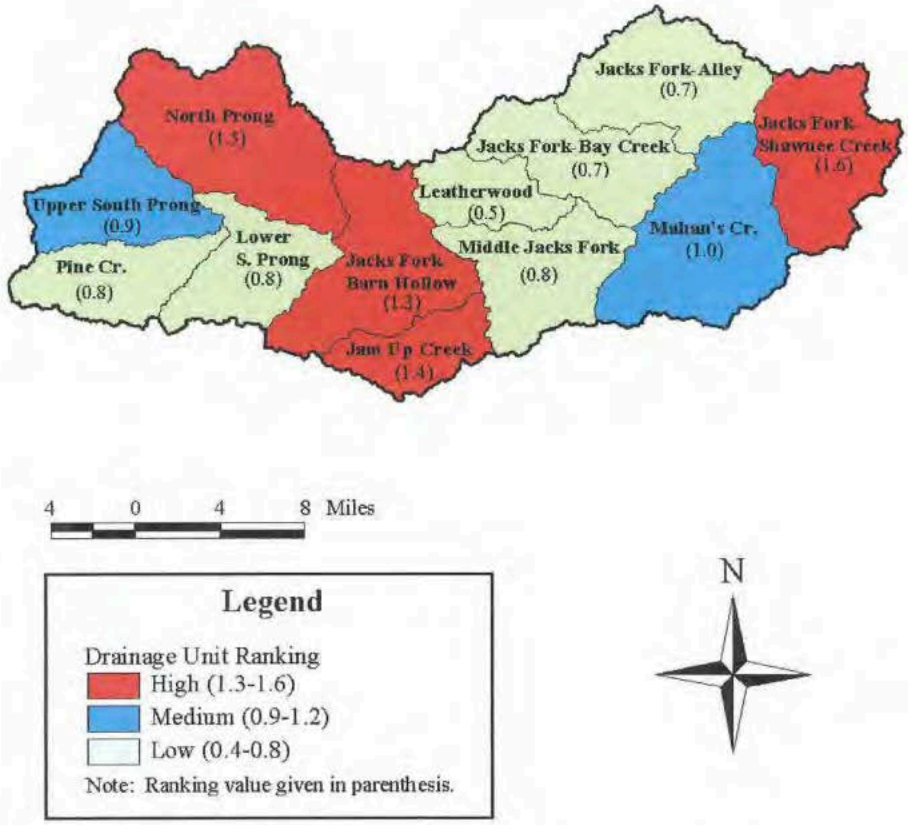
Strategy: Careful publicity which focuses on species of conservation concern, unique aquatic-oriented communities, as well as abundant recreationally valuable fish stocks can maintain and promote a continued appreciation of these different types of resource elements. Providing opportunities for the public to learn about stream ecology will, hopefully, create stream advocates.

1. Continue to provide annual fishing prospectus for public release to local media, describing the specific fisheries and angling opportunities of selected waters.
2. In cooperation with MDC Outreach and Education Division, provide the local and statewide media with timely "How to", "When to" articles and interviews that focus attention on places as well as both consumptive (i.e. gigging, float/wade fishing) and non-consumptive activities (i.e. snorkeling, floating, underwater photography)
3. Publicize the acquisition, development and opening of new public access and/or stream frontage sites.
4. In cooperation with MDC Regional Private Land Services and Outreach and Education personnel, emphasize stream ecology and good stream stewardship (utilizing brochures, aquaria, and stream tables where applicable) during presentations to school groups, youth organizations, and private landowner contacts.
5. Conduct outdoor youth events, such as Ecology Days at stream sites with field activities that demonstrate stream ecology and good stream stewardship.
6. Facilitate the development and activity of Stream Teams and other groups interested in adopting or otherwise promoting good stewardship and enjoyment of watershed streams.
7. Make public presentations in cooperation with regional private land services personnel that focus on the best management practices for private landowners.
8. Provide promotional, educational, and technical stream materials to groups, fairs and other special events.

9. In cooperation with regional private land services personnel, develop brochure which describes the watershed and promotes best management practices within the watershed.

Figure Mp01. **Jacks Fork Watershed**

Riparian Corridor Improvement Benefit Potential



Ranking factor based on the following formula: ((Rg+Rc+Ru+Sp+Sl)/3)(Au/Aw)+(S*0.1)
where:

Rg=Percent grassland riparian land use.
Rc=Percent cropland riparian land use.
Ru=Percent urban riparian land use.
Sp=Percent permanent stream.
Sl=Percent losing stream.
Au=Unit area.
Aw=Watershed area
S=Number of Aquatic Oriented Species of Conservation Concern observed.
(Only those records listed in MDC 1999c are included)

Angler Guide

The Jacks Fork River offers some of the finest stream fishing in the Ozarks. The premiere species is the smallmouth bass, with goggle eye (rock bass) running a close second in popularity. From the Highway 17 bridge downstream to the Highway 106 bridge, the Jacks Fork is a special Smallmouth Bass Research area. In this reach of stream, all smallmouth bass less than 18 inches must be immediately released unharmed and the daily limit of 6 bass can include only one smallmouth. These rules have increased the number of smallmouth bass and the number of fish in the 12- to 15-inch size range. While few fish reach the legal size of 18 inches, anglers can enjoy catching and releasing most of their catch with the knowledge that large fish are present in the best pools. Anglers who concentrate their fishing in these areas have the best chance of catching the largest fish. Goggle eye provide the best opportunity for anglers wishing to harvest fish, but other species like longear and green sunfish are also available.

The Special Smallmouth Bass Research Area is often floatable, but low water levels usually make this stretch more of a wading stream in the summer. Access by canoe is still possible, but anglers must be willing to pull their canoes over many of the shallow riffles. Below the confluence of Alley Spring, the Jacks Fork's flow is much more stable and can be floated year round. However, canoe traffic in this stretch can interfere with fishing in the summer, particularly on weekends.

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Glossary

Alluvial soil: Soil deposits resulting directly or indirectly from the sediment transport of streams, deposited in river beds, flood plains, and lakes.
Aquifer: An underground layer of porous, water-bearing rock, gravel, or sand.
Benthic: Bottom-dwelling; describes organisms which reside in or on any substrate.
Benthic macroinvertebrate: Bottom-dwelling (benthic) animals without backbones (invertebrate) that are visible with the naked eye (macro).
Biota: The animal and plant life of a region.
Biocriteria monitoring: The use of organisms to assess or monitor environmental conditions.
Channelization: The mechanical alteration of a stream which includes straightening or dredging of the existing channel, or creating a new channel to which the stream is diverted.
Concentrated animal feeding operation (CAFO): Large livestock (ie. cattle, chickens, turkeys, or hogs) production facilities that are considered a point source pollution, larger operations are regulated by the MDNR. Most CAFOs confine animals in large enclosed buildings, or feedlots and store liquid waste in closed lagoons or pits, or store dry manure in sheds. In many cases manure, both wet and dry, is broadcast overland.
Confining rock layer: A geologic layer through which water cannot easily move.
Chert: Hard sedimentary rock composed of microcrystalline quartz, usually light in color, common in the Springfield Plateau in gravel deposits. Resistance to chemical decay enables it to survive rough treatment from streams and other erosive forces.
Cubic feet per second (cfs): A measure of the amount of water (cubic feet) traveling past a known point for a given amount of time (one second), used to determine discharge.
Discharge: Volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic feet per second.
Disjunct: Separated or disjoined populations of organisms. Populations are said to be disjunct when they are geographically isolated from their main range.
Dissolved oxygen: The concentration of oxygen dissolved in water, expressed in milligrams per liter or as percent.
Dolomite: A magnesium rich, carbonate, sedimentary rock consisting mainly (more than 50% by weight) of the mineral dolomite ($CaMg(CO_3)_2$).
Endangered: In danger of becoming extinct.
Endemic: Found only in, or limited to, a particular geographic region or locality.
Environmental Protection Agency (EPA): A Federal organization, housed under the Executive branch, charged with protecting human health and safeguarding the natural environment — air, water, and land — upon which life depends.
Epilimnion: The upper layer of water in a lake that is characterized by a temperature gradient of less than 1° Celsius per meter of depth.
Eutrophication: The nutrient (nitrogen and phosphorus) enrichment of an aquatic ecosystem that promotes biological productivity.
Extirpated: Exterminated on a local basis, political or geographic portion of the range.
Faunal: The animals of a specified region or time.
Fecal coliform: A type of bacterium occurring in the guts of mammals. The degree of its presence in a lake or stream is used as an index of contamination from human or livestock waste.
Flow duration curve: A graphic representation of the number of times given quantities of flow are equaled or exceeded during a certain period of record.

Fragipans: A natural subsurface soil horizon seemingly cemented when dry, but when moist showing moderate to weak brittleness, usually low in organic matter, and very slow to permeate water.
Gage stations: The site on a stream or lake where hydrologic data is collected.
Gradient plots: A graph representing the gradient of a specified reach of stream. Elevation is represented on the Y-axis and length of channel is represented on the X- axis.
Hydropeaking: Rapid and frequent fluctuations in flow resulting from power generation by a hydroelectric dam's need to meet peak electrical demands.
Hydrologic unit (HUC): A subdivision of watersheds, generally 40,000-50,000 acres or less, created by the USGS. Hydrologic units do not represent true subwatersheds.
Hypolimnion: The region of a body of water that extends from the thermocline to the bottom and is essentially removed from major surface influences during periods of thermal stratification.
Incised: Deep, well defined channel with narrow width to depth ration, and limited or no lateral movement. Often newly formed, and as a result of rapid down-cutting in the substrate
Intermittent stream: One that has intervals of flow interspersed with intervals of no flow. A stream that ceases to flow for a time.
Karst topography: An area of limestone formations marked by sinkholes, caves, springs, and underground streams.
Loess: Loamy soils deposited by wind, often quite erodible.
Low flow: The lowest discharge recorded over a specified period of time.
Missouri Department of Conservation (MDC): Missouri agency charged with: protecting and managing the fish, forest, and wildlife resources of the state; serving the public and facilitating their participation in resource management activities; and providing opportunity for all citizens to use, enjoy, and learn about fish, forest, and wildlife resources.
Missouri Department of Natural Resources (MDNR): Missouri agency charged with preserving and protecting the state's natural, cultural, and energy resources and inspiring their enjoyment and responsible use for present and future generations.
Mean monthly flow: Arithmetic mean of the individual daily mean discharge of a stream for the given month.
Mean sea level (MSL): A measure of the surface of the Earth, usually represented in feet above mean sea level. MSL for conservation pool at Pomme de Terre Lake is 839 ft. MSL and Truman Lake conservation pool is 706 ft. MSL.
Nektonic: Organisms that live in the open water areas (mid and upper) of waterbodies and streams.
Non-point source: Source of pollution in which wastes are not released at a specific, identifiable point, but from numerous points that are spread out and difficult to identify and control, as compared to point sources.
National Pollution Discharge Elimination System (NPDES): Permits required under The Federal Clean Water Act authorizing point source discharges into waters of the United States in an effort to protect public health and the nation's waters.
Nutrification: Increased inputs, viewed as a pollutant, such as phosphorous or nitrogen, that fuel abnormally high organic growth in aquatic systems.
Optimal flow: Flow regime designed to maximize fishery potential.
Perennial streams: Streams fed continuously by a shallow water table an flowing year-round.

pH: Numeric value that describes the intensity of the acid or basic (alkaline) conditions of a solution. The pH scale is from 0 to 14, with the neutral point at 7.0. Values lower than 7 indicate the presence of acids and greater than 7.0 the presence of alkalis (bases).
Point source: Source of pollution that involves discharge of wastes from an identifiable point, such as a smokestack or sewage treatment plant.
Recurrence interval: The inverse probability that a certain flow will occur. It represents a mean time interval based on the distribution of flows over a period of record. A 2-year recurrence interval means that the flow event is expected, on average, once every two years.
Residuum: Unconsolidated and partially weathered mineral materials accumulated by disintegration of consolidated rock in place.
Riparian: Pertaining to, situated, or dwelling on the margin of a river or other body of water.
Riparian corridor: The parcel of land that includes the channel and an adjoining strip of the floodplain, generally considered to be 100 feet on each side of the channel.
7-day Q^{10}: Lowest 7-day flow that occurs an average of every ten years.
7-day Q^2: Lowest 7-day flow that occurs an average of every two years.
Solum: The upper and most weathered portion of the soil profile.
Special Area Land Treatment project (SALT): Small, state funded watershed programs overseen by MDNR and administered by local Soil and Water Conservation Districts. Salt projects are implemented in an attempt to slow or stop soil erosion.
Stream Habitat Annotation Device (SHAD): Qualitative method of describing stream corridor and instream habitat using a set of selected parameters and descriptors.
Stream gradient: The change of a stream in vertical elevation per unit of horizontal distance.
Stream order: A hierarchical ordering of streams based on the degree of branching. A first order stream is an unbranched or unforked stream. Two first order streams flow together to make a second order stream; two second order streams combine to make a third order stream. Stream order is often determined from 7.5 minute topographic maps.
Substrate: The mineral and/or organic material forming the bottom of a waterway or waterbody.
Thermocline: The plane or surface of maximum rate of decrease of temperature with respect to depth in a waterbody.
Threatened: A species likely to become endangered within the foreseeable future if certain conditions continue to deteriorate.
United States Army Corps of Engineers (USCOE) and now (USACE): Federal agency under control of the Army, responsible for certain regulation of water courses, some dams, wetlands, and flood control projects.
United States Geological Survey (USGS): Federal agency charged with providing reliable information to: describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect the quality of life.
Watershed: The total land area that water runs over or under when draining to a stream, river, pond, or lake.
Waste water treatment facility (WWTF): Facilities that store and process municipal sewage, before release. These facilities are under the regulation of the Missouri Department of Natural Resources.